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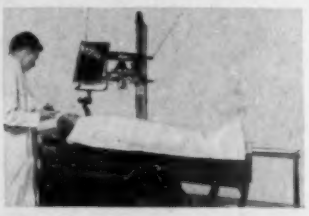

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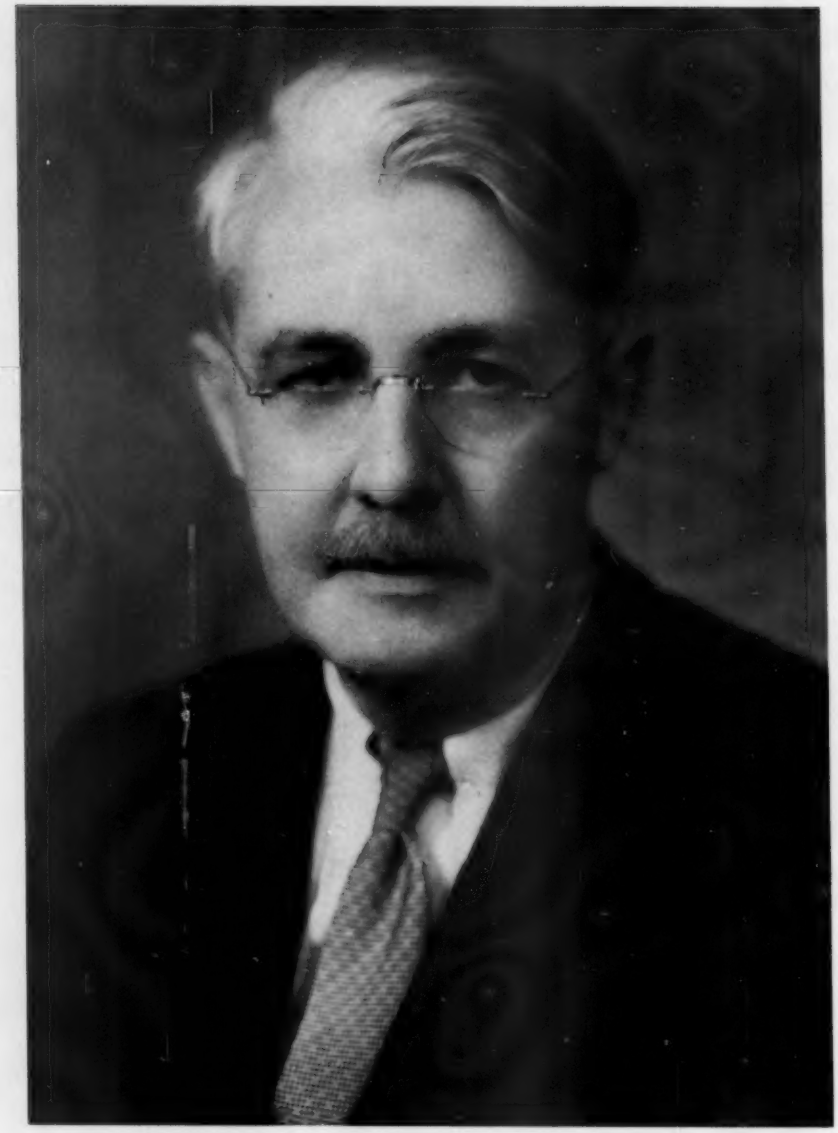

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PRESIDENT OF THE AMERICAN ROENTGEN RAY SOCIETY

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VOL. XXX OCTOBER, 1933 No. 4

SIGNIFICANCE OF ROENTGENOLOGIC CHANGES IN DIFFERENTIAL DIAGNOSIS OF ATELECTASIS*

By WILLIS F. MANGES, M.D., *and* JOHN T. FARRELL, JR., M.D.
PHILADELPHIA, PENNSYLVANIA

ATELECTASIS, or the absence of air in the alveoli, may be local, limited to a few of the alveoli, or general, involving a whole lobe or an entire lung. It is of two general varieties, congenital and acquired, and is associated with a number of conditions (Tables I, II, III and IV).

Bowen[2] in 1928 reviewed the literature of the condition up to that date, and while he was particularly interested in the postoperative form of atelectasis, his splendid paper contains an exhaustive bibliography of the whole subject.

Congenital atelectasis is commonly looked upon as a failure of the lung to expand because of maldevelopment of a bronchus, or of some fault of the respiratory mechanism. The acquired form is always due to bronchial occlusion.

In both congenital and acquired atelectasis, the roentgenographic findings fall into two classes: (1) increase in the density of the shadow of the collapsed lung or part of the lung due to the absence of air, and according to Sante[13] to vascular engorgement; (2) displacement of the mediastinal structures toward the side of the collapse with elevation of the diaphragm on the affected side (Table IV).

Congenital atelectasis is not a common occurrence, one of us[5] having failed to find an instance in a consecutive series of 150 infants examined roentgenographically within twenty-four hours of birth. Failure of the respiratory mechanism is generally considered the cause; but bronchial occlusion due to foreign material inhaled immediately after birth may be responsible, and cases looked upon as congenital may be acquired.

Congenital atelectasis is usually lobar and has the roentgenologic density of consolidation (Fig. 1); or it may be widely disseminated and made up of smaller patches. It is differentiated from enlarged thymus by the absence of thymic outline. Lobar pneumonia in the new-born is difficult to differentiate from congenital atelectasis; indeed, many cases diagnosed as pneumonia in new-born infants are probably atelectasis due to bronchial occlusion by aspirated foreign material.

Acquired atelectasis is always due to complete occlusion of a bronchus with absorption of the air distal to the occlusion. It is an accompaniment of several intrabronchial and a few extrabronchial conditions. Completely occluding foreign body, postoperative collapse of the lung, bronchial new growth, pneumonia, tuberculosis, and asthma, are conditions in which lesions within the bronchus are responsible for atelectasis. Enlarged tracheobronchial lymph

* Read at the Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27–30, 1932.

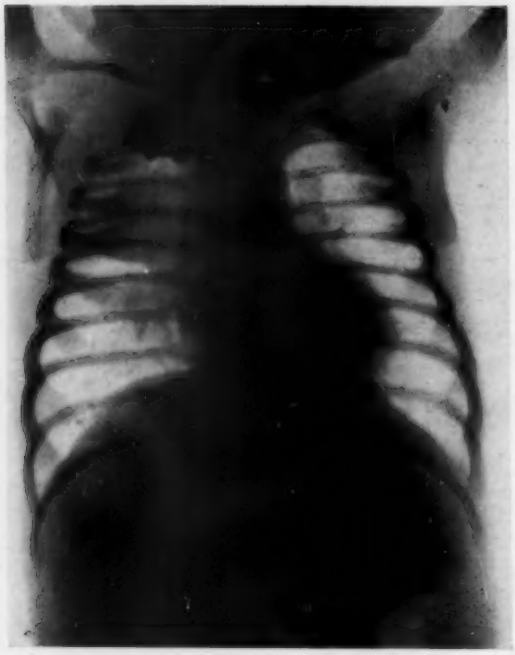

Fig. 1. Congenital atelectasis. Baby S., one day old; patient of Drs. Thaddeus L. Montgomery and Edward F. Burt; cyanosis, wheeze; upper portion of right chest evenly dense due to failure of upper lobe to expand. Ribs unelevated over this portion of chest. Roentgenograms made ten days later showed a normal chest.

nodes, mediastinal new growth and aneurysm are extrabronchial lesions, which by pressing on a bronchus, occlude it and lead to pulmonary collapse.

The roentgenologic changes of increased shadow density and displacement of the mediastinal structures and diaphragm are the same, regardless of the condition with which the atelectasis is associated. The findings vary, however, with the size of the bronchus occluded, the side involved, the duration of the collapse and the character of the changes in the bronchus and pulmonary parenchyma secondary to the bronchial lesion.

Alterations in the roentgenologic appearance of the chest secondary to totally occluding bronchial foreign body based on clinical observations have been described by one of us (Manges).[10,11,12] Heller,[8] among others, has described the changes observed clinically and experimentally. The atelectatic changes in foreign body demonstrate well the effect of total bronchial occlusion and will be presented in detail.

Totally occluding bronchial foreign bodies occur more frequently in children than

Table I

MECHANICS AND INCIDENCE

	Type	Occluding Factor	Incidence of Atelectasis in Primary Condition
	Congenital	1. Respiratory dysfunction 2. Inhalation of foreign material	Rare
Due to occlusion by intrabronchial plugging	Foreign body	Foreign body	Occasional
	Bronchial neoplasm	Neoplasm	Usual
	Postoperative	Tenacious secretion	Always
	Pneumonia	Pneumococcic exudate	Always (Coryllos and Birnbaum)
	Tuberculosis	Granulations	Uncommon
	Asthma	Tenacious secretion	Rare
Due to occlusion by extrabronchial pressure	Tracheobronchial nodes	Pressure by nodes	Rare
	Mediastinal neoplasm	Pressure by growth	Rare
	Aneurysm	Pressure by aneurysm	Rare
	Extrabronchial pulmonary neoplasm	Pressure by neoplasm	Common

in adults and are usually organic in origin, the dried navy bean being the most frequently encountered. However, inorganic foreign bodies may produce atelectasis; in one instance the inhalation of a steel bullet was responsible for the condition.

With total occlusion of a bronchus by a foreign body it is impossible for air to enter or leave the lung distal to the point of lodgment. Jackson calls this type of foreign body the stop-valve. Absorption of the air trapped in the lung by the foreign body follows and the alveoli collapse. Collapse is due to the fact that, after the intrapulmonary pressure has been reduced to less than atmospheric by the cutting off of the alveoli from the outside air, the negative pressure in the pleural cavity is not sufficient to counteract the contracting force of the pulmonary elastic tissue. Decrease in air content leads to diminution in the size of the lung.

Alteration in the roentgen appearance due to collapse becomes evident as a loss of illumination on the side involved (Fig. 2). This is so marked that the collapsed lung cannot be differentiated from the shadow of the heart and other mediastinal structures and the diaphragm.

The extent of the area of increased density is determined by the amount of lung tissue normally supplied by the occluded bronchus. Closure of a main bronchus leads to collapse of the whole lung; of a branch bronchus, to collapse of a smaller area; in the case of a lobar branch, of a lobe; in the

Fig. 2. Total collapse of right lung following aspiration of bean. M.C., aged five; patient of Dr. Louis H. Clerf; bean aspirated twenty-four hours earlier; right half of the chest evenly dense due to collapse, heart and mediastinal structures displaced far to the right.

Table II

CLINICAL SIGNIFICANCE

	Age Incidence	Prognostic Significance
Congenital	New-born	
Foreign body	Childhood	
Bronchial neoplasm	Middle age	
Postoperative (massive atelectasis)	Any age, usually adult	
Pneumonia	Any age	
Tuberculosis	Early adult, middle age	
Asthma	Adult	
Enlarged tracheobronchial nodes	Infancy and childhood	Grave
Mediastinal neoplasm	Middle and late adult	Grave
Aneurysm	Late adult	Grave
Extrabronchial pulmonary neoplasm	Middle age	

case of a small branch, of only part of a lobe.

Changes in the position of the thoracic viscera accompany atelectasis. Diminution in the size of the collapsed lung leads to compensatory emphysema of normal pulmonary tissue. This overdistention of the normal lung forces the movable mediastinal structures away from the uninvolved side toward the side of the atelectasis.

The degree of displacement is determined by the side involved as well as the site of the occlusion, and by the feasibility of the mediastinal structures. Closure of the bronchi supplying the left lung is accompanied by less marked displacement than when the right lung is involved. When but a single lobe is collapsed displacement is not so great as when all the lobes of a lung are involved.

Atelectasis secondary to foreign body occlusion takes place rapidly. We have seen complete collapse of the lung develop in a child six hours after the inhalation of the foreign body. Lee, Ravdin, Tucker and Pendergrass[9] were able to produce atelectasis experimentally in two hours in the dog.

In foreign body atelectasis the duration of the roentgenographic signs after removal of the foreign body depends directly upon the length of sojourn of the foreign body. If the foreign body is removed promptly, expansion of the lung takes place quickly, the displaced viscera return to their normal positions and the chest resumes a wholly normal roentgenologic appearance in a brief time (Fig. 3). The entire process of occlusion, atelectasis, evacuation and re-expansion may take place in a few hours.

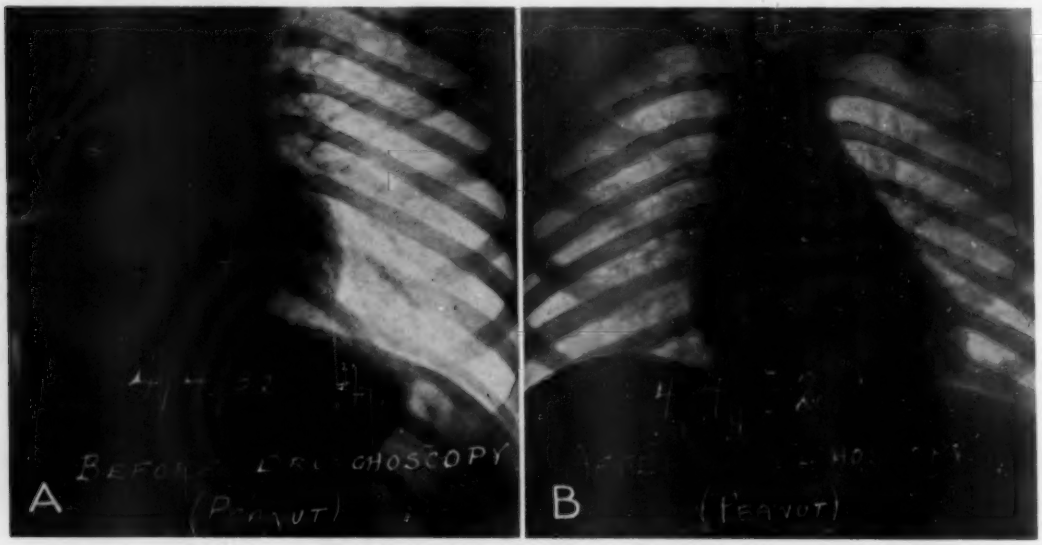

Fig. 3. Rapid re-expansion of atelectatic lung after early removal of occluding foreign body. B.T., aged five; patient of Dr. Louis H. Clerf; peanut aspirated April 3, 1932; dyspnea, cyanosis, loss of consciousness for a few minutes. A. April 4, 1932, seventeen hours after onset; right lung increased in density, heart displaced to right, right half of diaphragm elevated. B. April 4, 1932, one hour after Dr. Clerf had removed a peanut from the right main bronchus. Lung re-expanded, markings practically normal.

Two varieties of intrabronchial pathological changes follow longer sojourn of foreign body in the bronchus: (1) a local reaction in the bronchial mucous membrane at the site of lodgment; (2) changes in the pulmonary tissues distal to the site of occlusion. The latter are drowned lung, chronic atelectasis, fibrosis and bronchiectasis.

Vegetal foreign bodies, such as the dried navy bean, swell when held in the bronchus for any length of time. This swelling is ac-

companied by traumatization of the mucous membrane. In some instances pressure on the swollen foreign body by the walls of the bronchus forces the object upward, an action similar to that following the squeezing of a moistened hard object between the thumb and finger. Shifting by this action of a foreign body from one main bronchus to the other may lead to sudden death, because collapse of the formerly sound lung may take place before the lung which first became atelectatic has become sufficiently aerated. With conversion of a bronchial into a tracheal foreign body re-expansion of the atelectatic lung takes place, and the roentgenographic signs become those of tracheal foreign body.

Rapidly developing foreign body atelectasis is accompanied by retention of bronchial secretions in the lung distal to the occlusion, a condition known as drowned lung. This does not occur in postoperative collapse. Bowen[2] says that drowned lung occurs in foreign body atelectasis because the rapidity of onset prevents adjustment of the secretory function and mechanism, while in postoperative collapse the etiologic factor, a conversion of the normal thin bronchial secretion into a thick ropy substance, permits of adjustment.

The influence of drowned lung on the roentgenographic appearance of the atelectatic lung is determined by the duration of the collapse and the local pathological changes at the site of occlusion. With prompt removal of the foreign body and re-expansion of the lung the retained secretions are rapidly expelled from the collapsed area and no appreciable roentgenologic alteration remains.

Prolongation of collapse is followed by infection of the retained secretions, and even after the occluding object has been removed from the bronchus and the atelectasis relieved there is a residual increase in the density of the shadows of the in-

Table III

CLINICAL CHARACTERISTICS

Type	Onset	Symptoms	Constitutional Reaction	Commonest Sequelae
Congenital	Immediate	Dyspnea, cyanosis, wheeze	Mild	None
Foreign body	Sudden	Cough, dyspnea, wheeze	Moderate to severe	Pneumonitis, bronchiectasis
Bronchial neoplasm	Gradual	Cough, expectoration, hemoptysis, pain	Mild	Pneumonitis, abscess
Postoperative	Sudden	Dyspnea, cough, pain, cyanosis	Severe ("Catastrophe" Lee)	Usually none
Pneumonia	Sudden	Cough, dyspnea, cyanosis, pain	Severe	Empyema, abscess
Tuberculosis	Gradual	Cough, expectoration, dyspnea	Mild	Bronchiectasis
Asthma	Sudden	Dyspnea, wheeze	Severe	None
Tracheobronchial nodes	Gradual	Cough, dyspnea	Severe	Empyema
Mediastinal neoplasm	Gradual	Cough, dyspnea	Severe	Pneumonitis, abscess
Aneurysm	Gradual	Cough, dyspnea	Mild	Pneumonitis, abscess
Extrabronchial pulmonary neoplasm	Gradual	Cough, pain	Mild	Abscess

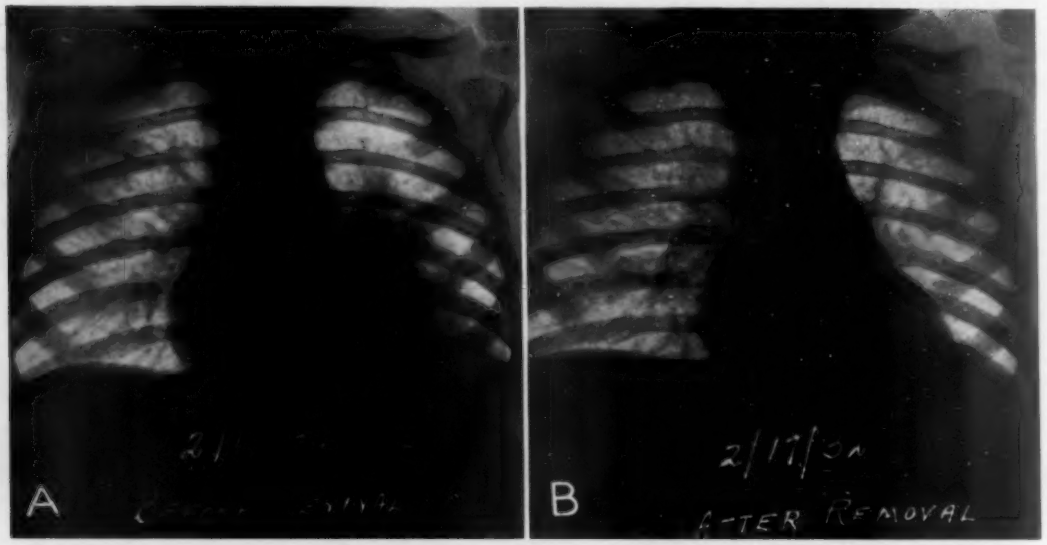

Fig. 4. Residual increased density due to prolonged bronchial occlusion and atelectasis. C.A., aged two; patient of Dr. Louis H. Clerf; peanut aspirated January 31, 1932; cough, wheeze, expectoration and fever. A. February 13, 1932, two weeks after onset; lower half of left lung increased in density. B. February 17, 1932, four days after bronchoscopic removal of peanut from left lower lobe bronchus by Dr. Clerf. Markings still increased over lower lobe, left half of diaphragm elevated.

volved lung (Fig. 4). This residual increase may be marked and approach that of atelectasis, or it may be made up of a varying number of independent dense areas due to suppurative foci.

When collapse has not been prolonged and no local bronchial lesion interferes with drainage, the roentgenologic changes due to infection of the drowned lung gradually disappear. The length of time required for complete disappearance varies from a few days to several weeks.

Table IV

ROENTGENOLOGIC CHARACTERISTICS

Type	Roentgenologic Density	Distribution	Displacement
Congenital	Varies with involvement	Lobar, lobular, entire lung	Not marked
Foreign body	Varies with involvement	Lobar, entire lung	Varies with involvement
Bronchial neoplasm	Varies with involvement	Lobar, lobular, entire lung	Varies with involvement
Postoperative	Usually marked	Entire lung, lobar, bronchopneumonic	Marked
Pneumonia	Marked	Lobar	Moderate, not as marked as postoperative
Tuberculosis	Varies with involvement	Lobular, lobar	Varies with involvement
Asthma	Marked	Lobar	Marked
Tracheobronchial nodes	Marked	Lower lobes	Marked
Mediastinal neoplasm	Marked	Lower lobes	Varies
Aneurysm	Marked	Lobar	Varies
Extrabronchial pulmonary neoplasm	Varies with involvement	Lobar	Not marked

Sometimes, inflammatory changes in the retained secretions increase so rapidly in amount that they exert pressure on the occluding foreign body and dislodge it. This uncorking of the bronchus is followed by re-expansion of the atelectatic lung; the effect on the roentgenographic appearance of the chest being again determined by the duration of the collapse, and the extent of the inflammatory changes in the occluded bronchus and atelectatic lung.

occlusion is characterized by the development of bronchiectasis with cavities and extensive fibrous tissue changes throughout the collapsed lung (Figs. 5 and 6). Bronchiectasis secondary to atelectasis is usually unilateral and shows the characteristic displacement of the mediastinal structures toward the side of involvement, together with elevation of the diaphragm. It is accompanied by expectoration of purulent exudate and other evidences of infection.

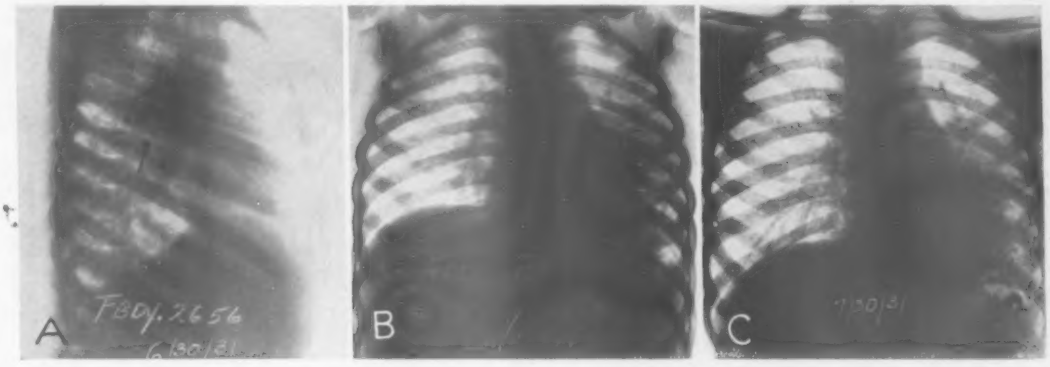

Fig. 5. Bronchiectasis secondary to foreign body atelectasis. W.F., aged seven and a half; patient of Dr. Louis H. Clerf; no history of foreign body aspiration; onset four to six months before admission with cough, expectoration of fetid pus and fever. A. Lateral view of the chest showing nail in bronchus; even in this view increased markings of lower portion of lung are apparent. B. Marked residual density still present one month after bronchoscopic removal of nail by Dr. Clerf. C. Bronchiectatic cavities outlined by iodized oil. These changes are permanent and the direct result of inflammatory processes in the atelectatic lung.

Localized trauma at the site of foreign body lodgment influences greatly the roentgenographic appearance of the atelectatic lung, even after the foreign body has been removed. Injury to the mucous membrane produces granulation tissue which, acting as a foreign body, interferes with aeration of the lung and prevents drainage. The collapsed lung, therefore, cannot expand readily, and this, together with the retained secretions, leads to continued density of the involved lung and to displacement of the viscera. The amount of increased density and the degree of displacement depend upon the degree of stenosis produced by the granulation tissue, the duration of the atelectasis and the size of the area involved.

Chronic atelectasis from foreign body

It may be mistaken for congenital cystic disease of the lung. Careful questioning will sometimes unearth a history of foreign body aspiration as the etiologic factor.

Scar formation with residual stenosis of the bronchus produced by a foreign body may also terminate in bronchiectasis even after the atelectasis has been relieved by the removal of the foreign body.

Bronchial neoplasm is essentially a foreign body of intrabronchial origin which, by occluding the bronchus at one point, produces atelectasis in much the same way as the inhaled foreign body. Atelectasis accompanying bronchial new growth produces clinical and roentgenologic characteristics important in differentiating it from other pulmonary diseases.

New growth of the bronchus is frequently so insidious in onset that atelectasis of an entire lung has taken place when the patient first comes under observation. There is a stage in its development when, acting as a check valve permitting air to enter but preventing its exit, the new growth produces obstructive emphysema.

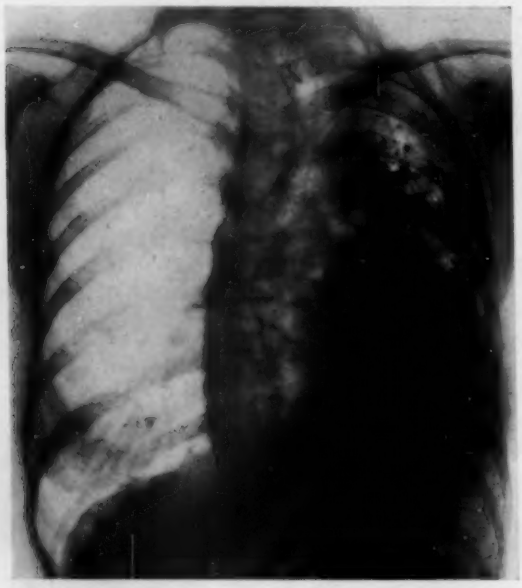

Fig. 6. Extensive bronchiectasis secondary to foreign body atelectasis. B.C., aged thirty-seven; patient of Dr. Chevalier Jackson. As child of five aspirated a coffee bean, severely ill with attack similar to pneumonia for two months. After one month coughed up bean, and was never afterwards free of cough and expectoration. At twelve years, and again at eighteen, had prostrating attacks of illness with cough, expectoration of fetid pus and fever. For fourteen months prior to admission was in a tuberculosis sanatorium, sputum always negative for tubercle bacilli. Iodized oil outlines numerous large cavities in the left lung; heart and trachea displaced to the left; left hemithorax atrophied.

Respiratory dysfunction at this time is apparently not great, and patients do not usually seek medical advice during this stage. It is possible that the condition is sometimes overlooked because its symptoms are protean and its signs vague.

Continued growth of the tumor leads to total occlusion of the bronchus with subsequent atelectasis (Fig. 7A). The extent of the atelectasis depends upon the site in the bronchus at which the tumor arises, and this, with the duration of the atelectasis and the type of secondary change, determines the roentgenologic characteristics of the collapsed area.

Tumors arising in a main bronchus produce complete collapse of the lung on the side of the tumor with even opacity of the shadow, and displacement of the thoracic viscera toward it. When the tumor arises from a branch bronchus collapse is confined to a lobe with increase in the density of the shadow limited to the projection of the lobe and with less visceral displacement than when the entire lung is collapsed.

Removal of the obstruction by bronchoscopic removal of the tumor allows air to enter and re-expand the lung, restoring the viscera to their normal positions (Fig. 7B). The time required for this varies with the duration of the collapse and the extent of the secondary changes. Ashbury[1] reported a case in which the lung collapsed and re-expanded three times in sixteen months; in one interval expansion followed bronchoscopic removal of the tumor by Clerf. Figure 7B is of a patient whose lung had been atelectatic for seven months. Eleven weeks were required for partial re-expansion; roentgenograms made immediately after bronchoscopic removal of the tumor and for several weeks thereafter showed no appreciable difference from those made before bronchoscopy.

Roentgenographic signs of atelectasis are important in the differentiation of pulmonary abscess secondary to neoplasm from abscess unassociated with neoplasm. In pulmonary abscess uncomplicated by new growth, displacement phenomena are absent unless there is pleural involvement; then the diaphragm alone is affected, the mediastinal structures remaining in their normal position. In abscess following bronchial new growth there is practically always displacement of the thoracic organs toward the side of involvement (Fig. 8). The difference in displacement is probably accounted for by the difference in the mode

of development of the two varieties of abscess.

Acute non-neoplastic abscess follows entrance of infected material into the alveoli in an amount great enough to set up a suppurative focus, but not large enough to produce bronchial obstruction and subsequent atelectasis. Destruction extends centrifugally from a central point of origin.

Extension of the tumor from its primary site in the bronchus into the atelectatic pulmonary tissue converts the pulmonary tissue into a neoplastic mass. Necrosis of the center of the tumor and bacterial invasion bring about abscess and cavity formation. The collapsed lung remains diminished in size because the neoplastic tissue cannot expand, and, as a consequence, the thoracic viscera are held in their position of displacement.

Atelectasis as a complication of surgical operation is also known as postoperative massive pulmonary collapse. Bowen treats of it exhaustively from the historical, clinical, experimental and roentgenologic aspects.

Postoperative atelectasis is due to occlusion of a bronchus by the accumulation of tenacious secretions too thick for the patient to expectorate. Its clinical and roentgenologic characteristics help to differentiate it from other conditions and from atelectasis of other origin. Because of increasing interest and wider recognition by those who have the postoperative care of the patient it is more frequently recognized now than formerly. This type may occur at any age; but it is seen in adults more often than in the young. Hearn and Clerf[7] reported a case in a child of seven years.

Clinically, sudden onset shortly after operation and marked respiratory embarrassment out of proportion to the temperature and pulse elevation characterize it. It usually comes on within thirty-six hours of operation and may develop fully in that time; or it may begin with the first day but not reach its height for six or seven days.

Roentgenologically postoperative collapse varies with the extent of the collapse.

Fig. 7. Atelectasis due to bronchial carcinoma. E.P., aged forty-one; patient of Dr. Louis H. Clerf. A. February 10, 1932, sixteen months after onset with cough, fever and night sweats. Left lung evenly dense, with displacement of mediastinal structures and elevation of the diaphragm. B. April 26, 1932, partial re-expansion of the left lung after bronchoscopic removal of the tumor by Dr. Clerf.

Fig. 8. Abscess in neoplastic atelectasis secondary to bronchial carcinoma. W.B., aged fifty-nine; patient of Dr. Chevalier Jackson. Cough, hemoptysis, expectoration of pus, pain. At bronchoscopy Dr. Clerf found neoplastic tissue diagnosed histologically carcinoma by Dr. Baxter L. Crawford. Cavity formation and inflammatory changes throughout the right lung. Note the marked displacement of the heart and diaphragm which are not usually present in non-neoplastic pulmonary abscess.

Early in its course in some cases there is an increase in the shadows of the involved lung with elevation of the diaphragm on the affected side (Fig. 9). The increased density of the lung is not so great that the pulmonary shadows cannot be differentiated from the heart and diaphragm. This stage is not often seen in foreign body occlusion or in occlusion due to bronchial new growth. Progression of the process ends in the development of a shadow as dense as that of the heart and diaphragm from which the lung cannot be differentiated (Fig. 10).

Fixation as well as elevation of the diaphragm on the involved side can be recognized on roentgenoscopic examination early in the course of the disease.

When the bronchi of one lobe only are occluded increase in the density of the shadow is limited to the projection of that lobe, and the mediastinal viscera are not displaced as much as they are when an entire lung is involved.

Postoperative atelectasis is sometimes patchy in distribution. In a patient whose case was reported by Scheffey, Jones and Clerf[14] we found areas of increased density

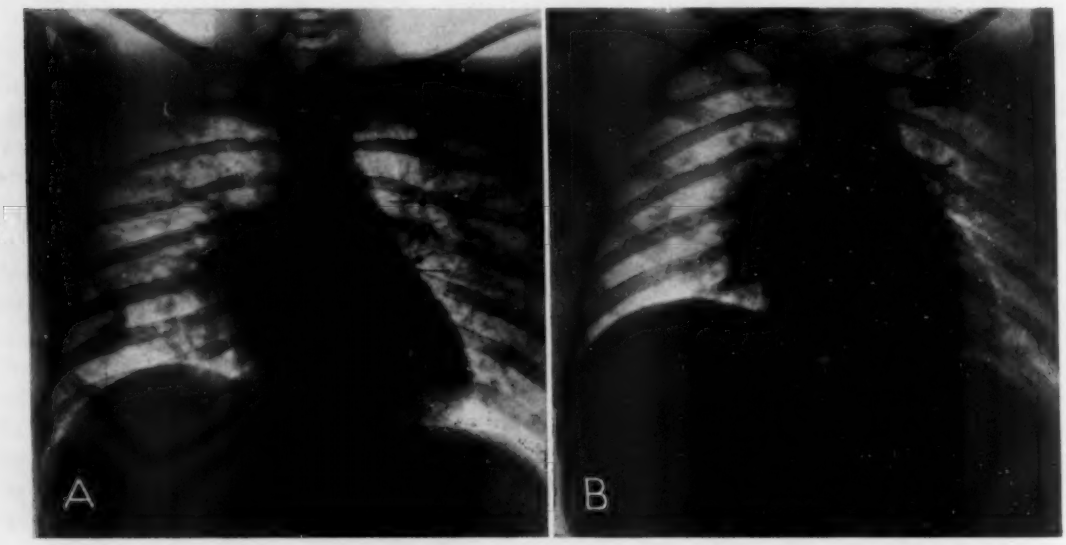

Fig. 9, A and B. Elevation and fixation of the diaphragm in early postoperative atelectasis. R.S., aged twenty-eight; patient of Dr. P. Brooke Bland. Onset two days after forceps delivery, with dyspnea and fever; marked increase in shadows at right root area.

scattered throughout an otherwise well aerated lung. In this patient the diaphragm was elevated and fixed, but there was only slight displacement of the heart.

While postoperative atelectasis tends to disappear spontaneously, it may require several weeks for the lung to return to normal, if the patient is not treated. After bronchoscopic removal of the secretion recovery is rapid, the lung assuming a normal appearance and the viscera returning to normal, sometimes within twenty-four hours. Occasionally, the condition recurs as in the instance reported by Hearn and Clerf in which Clerf did seven bronchoscopies before the patient fully recovered.

Unlike atelectasis from prolonged foreign body sojourn or bronchial neoplasm, postoperative massive collapse usually subsides without sequelae. Drowned lung, chronic atelectasis, bronchiectasis or abscess, as sometimes seen after atelectasis due to foreign body or neoplastic bronchial occlusion, do not occur. Bowen thinks that this is because postoperative collapse is really due to a disturbance of bronchial secretory function to which the lung adjusts itself, while, when the condition is due to occlusion by foreign body or bronchial new growth there is no regulation of the secretory mechanism and the interference with drainage ends in drowned lung, with its potentiality for infective changes.

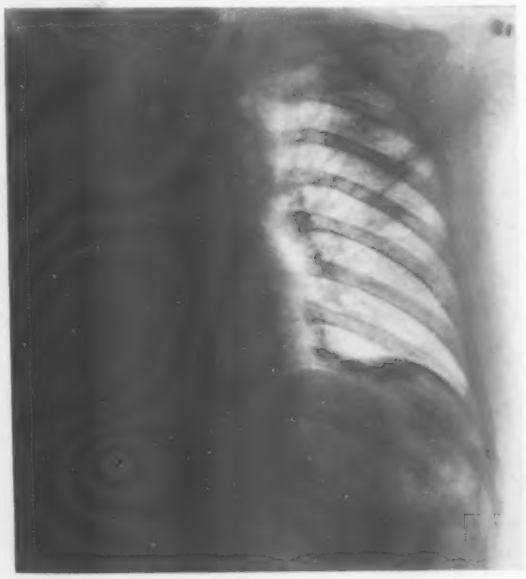

Fig. 10. Acute massive postoperative collapse of the lung. R.R., aged forty-nine; patient of Dr. Thomas A. Shallow; onset with dyspnea, pain in the chest and fever two days after herniorrhaphy. Atelectatic lung has the density of the heart and diaphragm, marked displacement of the thoracic viscera to the right.

Fig. 11. Atelectasis secondary to tuberculous stenosis of the right bronchus. L.T., aged twenty-six; patient of Dr. Edward J. Klopp; cough, expectoration, pain in the chest and dyspnea. At bronchoscopy Dr. Clerf found a stenosis of the right bronchus with greatly thickened mucosa, tubercle bacilli in the sputum. Thoracoplasty by Dr. John B. Flick brought relief of symptoms. Right lung collapsed with evidence of cavity formation, marked displacement.

The occurrence of atelectasis during the course of chronic pulmonary tuberculosis is not generally recognized. Sproull[15] in 1928 failed to find any mention of it in the English literature. It probably follows occlusion of the bronchus by tuberculous granulations in much the same manner that intrabronchial neoplasm produces occlusion. The atelectatic process may even be preceded by the rarely recognized stage of obstructive emphysema, an instance of which was mentioned by one of us (Farrell).[6]

Atelectasis in tuberculosis in most instances is probably confined to areas

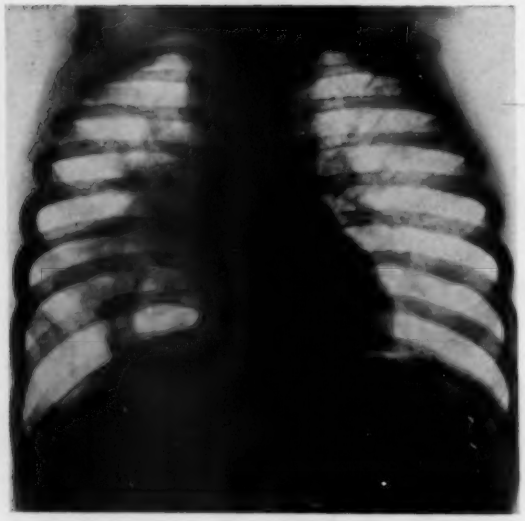

Fig. 12. Atelectasis secondary to enlarged tracheobronchial lymph nodes. J.A., aged nineteen months; patient of Dr. Louis H. Clerf. Whooping cough seven months before admission, productive cough since, loss of weight, slight wheeze. Manteaux test strongly positive. At bronchoscopy Dr. Clerf found compression stenosis of the trachea and right bronchus. Marked increased density in mid-portion of right lung, displacement of the trachea, heart and mediastinum, tubercles can be seen in the left lung.

smaller than a lobe and the roentgenologic characteristics are masked by other tuberculous changes. The increased density of the tissue is usually thought to be due to massive caseation or organization, and the displacement to fibrous tissue formation (Fig. 11). Caseation is unassociated with visceral displacement, and displacement of the mediastinal structures secondary to scar tissue contraction is ordinarily not as marked as that due to atelectasis.

Coryllos and Birnbaum[4] consider lobar pneumonia a pneumococcic atelectasis. The even density of the area of pneumonia and the associated visceral displacement toward the side of involvement are of the character seen in atelectasis of other etiology, though the displacement phenomena are usually less pronounced. It is safe to say that atelectasis, in the sense of diminished volume of the lung due to displacement of alveolar air, is associated with lobar pneumonia. The systemic toxic features of the disease, however, are much more marked than those seen with atelectasis due to foreign body, bronchial new growth or postoperative massive collapse. In all probability the atelectasis is only the local manifestation of a general systemic disease, though the mechanism of its production, bronchial occlusion, is the same.

In some patients with asthma atelectasis of sudden occurrence is responsible for attacks of dyspnea. This happened to several patients studied by us whose case histories were reported by Clarke.[3] The condition is probably of more frequent occurrence than is generally realized. Plugging of a bronchus with mucus may well be the causative factor in these allergic patients.

The roentgenographic findings in Clarke's patients were those of classical atelectasis, complete opacity of the col-

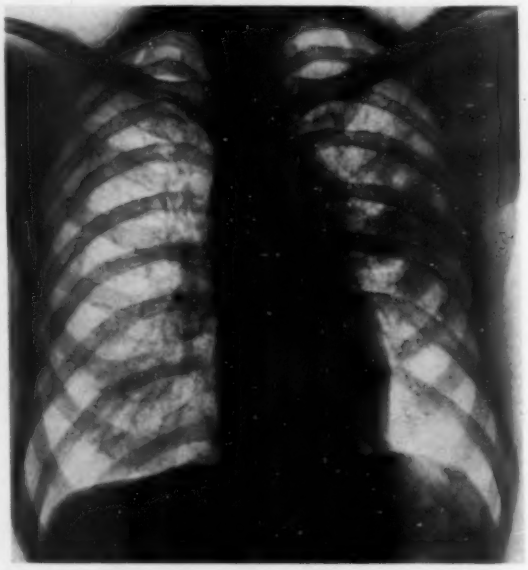

Fig. 13. Localized atelectasis from pressure of mediastinal sarcoma. A. L., aged forty-five; patient of Dr. Chevalier Jackson; dysphagia, regurgitation, pain in the chest and back. Patient died five days after admission; at necropsy Dr. Carl J. Bucher found a mediastinal sarcoma, pressing upon the esophagus and producing collapse of the lung. Mediastinal shadow broadened, heart displaced, diaphragm elevated, localized increased density in mid-portion of left lung.

lapsed lobes and displacement of the heart and mediastinal structures toward this side of the chest. With re-expansion dyspnea lessened, the lungs assumed their usual emphysematous appearance, and the mediastinal structures returned to their normal positions.

Extrabronchial pressure leading to occlusion of the bronchus is not so common a cause of atelectasis as is closure of the bronchus due to plugging from within. The atelectasis is, however, of graver clinical significance. In most of these patients the prognosis is less favorable than in those in whom the occlusion is intrinsic in origin. The gravity is due in most part to the seriousness of the conditions with which the atelectasis is associated; but in part, also, to the atelectasis itself which may even become bilateral.

Massive collapse due to extrabronchial pressure may occur at any age, though particular causes are operative in particular age groups. In infants and children enlarged tracheobronchial lymph nodes may be responsible for the occlusion; in adults, mediastinal new growth, aneurysm and extrabronchial pulmonary neoplasm are the most frequently encountered causes.

Enlargement of the mediastinal nodes in children to a size sufficient to produce occluding bronchial pressure is always tuberculous in origin.

It is probably seen only when the nodes are fixed to the bronchi by fibrous tissue formation. As the nodes increase in size they occlude the bronchus by pressing on it from without. When not adherent enlarged nodes merely displace the bronchi and do not occlude them.

The lower lobes are more frequently involved than the upper, and the shadow of the lesion is often of an irregular pattern as though the collapse extended beyond the limits of the lobe.

Marked displacement of the mediastinal structures is often associated with the occlusion. At other times, because the lesion is bilateral and involves both lower lobes, displacement is less pronounced.

Occasionally, the etiologic factor responsible for the enlargement is made evident by the presence of tuberculous deposits in the parenchyma at such a distance from the collapsed portions that they can be recognized (Fig. 12).

Gradual increase in the size of the nodes may trap secretions beyond the point of narrowing and drowned lung and infective changes may develop before the occlusion becomes complete and ends in atelectasis.

Aneurysm and mediastinal new growth may lead to atelectasis when they prevent the entrance of air into a portion of the lung by occluding the bronchus by pressure. It is not a common occurrence. We have seen one case at post mortem in which three lobes, the two lower and the right middle, were collapsed because of pressure made on the bronchi close to the bifurcation by an aneurysm. The ante-mortem roentgenogram showed bilateral increased density of the lower portions of the chest without displacement of the thoracic viscera. Figure 13 is of a patient in whom pressure from a sarcoma of the mediastinum was found at post mortem to be responsible for atelectasis as well as for atresia of the esophagus.

Extrabronchial pulmonary neoplasm sometimes produces atelectasis by pressing on bronchi. There is nothing characteristic in the changes they produce. Necrosis of the center of the neoplastic mass and evacuation of the contents leads to the formation of a cavity. As in the case of abscess secondary to intrabronchial neoplasm there is marked displacement of the thoracic viscera toward the side of involvement, a condition not ordinarily found in non-neoplastic pulmonary abscess.

SUMMARY

1. Atelectasis has certain roentgen characteristics serving to differentiate it from other conditions.

2. Congenital atelectasis is uncommon, and though usually considered due to respiratory dysfunction, it may follow occlusion of a bronchus by material aspirated with the first few inspirations after birth.

3. Acquired atelectasis in bronchial foreign body, bronchial neoplasm, postoperative massive collapse, pneumonia, tuberculisis, and asthma, is due to intrabronchial plugging; and in enlarged tracheobronchial lymph nodes, aneurysm, mediastinal new growth and extrabronchial pulmonary neoplasm it follows occlusion of the bronchus from extrabronchial pressure.

4. Roentgen phenomena of atelectasis fall into two classes: (1) increase in the density of the shadows of the involved portion of the lung, (2) displacement of the heart and other mediastinal structures toward the side of involvement, with elevation of the diaphragm on the affected side.

5. The characteristics and significance of these roentgen signs vary with the cause, the bronchus involved, the duration of the collapse and its sequelae.

6. Atelectasis due to aspirated foreign body and bronchial neoplasm is frequently followed by inflammatory changes, abscess and bronchiectasis.

7. The close association of atelectasis and bronchiectasis is not generally recognized.

8. The acute postoperative form of atelectasis, pneumococcic atelectasis, and atelectasis in asthma usually resolve without serious sequelae and no roentgenologically recognizable residues.

9. In tuberculosis atelectasis may disappear spontaneously leaving no sign or it may become chronic and end in bronchiectasis.

10. Displacement phenomena accompanying abscess suggest strongly a neoplastic origin for the abscess, because they indicate that atelectasis preceded it, a rare condition in non-neoplastic abscess.

11. Atelectasis, while rare in the extrabronchial lesions, enlarged tracheobronchial nodes, mediastinal new growth, and aneurysm, is a grave prognostic sign. When due to pressure from an extrabronchial pulmonary new growth it is of less serious import.

REFERENCES

1. Ashbury, H. E. Recurrent massive collapse of the lung due to a benign intrabronchial tumor. Am. J. Roentgenol. & Rad. Therapy, 1929, *21*, 452–459.
2. Bowen, D. R. Acute massive collapse (atelectasis) of the lung. Am. J. Roentgenol. & Rad. Therapy, 1929, *21*, 101–141.
3. Clarke, J. A., Jr. Pulmonary atelectasis as a complication of bronchial asthma. *Arch. Int. Med.*, 1930, *45*, 624–630.
4. Coryllos, P. N., and Birnbaum, G. L. Lobar pneumonia considered as a pneumococcic lobar atelectasis of the lung; bronchoscopic investigation. *Arch. Surg.*, 1929, *18*, 190–241.
5. Farrell, J. T., Jr. The roentgen appearance of the chest of the new-born infant. Am. J. Roentgenol. & Rad. Therapy, 1930, *24*, 140–146.
6. Farrell, J. T., Jr. The roentgen diagnosis of intrathoracic neoplasms. *Radiology*, 1929, *13*, 1–16.
7. Hearn, W. P., and Clerf, L. H. Post-operative massive collapse of the lung. *Ann. Surg.*, 1927, *85*, 54–60.
8. Heller. Klinische und experimentelle Beiträge zur Kenntnis der akuten Lungenatelektase durch obturierenden Fremdkörperverschluss der Bronchien. *Ztschr. f. d. ges. exper. Med.*, 1913–1914, *2*, 453–484.
9. Lee, W. E., Ravdin, I. S., Tucker, G., and Pendergrass, E. P. Studies on experimental pulmonary atelectasis. *Ann. Surg.*, 1928, *88*, 15–20.
10. Manges, W. F. Atelectasis as a roentgen-ray sign of foreign body in the air passages. Am. J. Roentgenol. & Rad. Therapy, 1924, *11*, 517–523.
11. Manges, W. F. Non-opaque foreign bodies in the air passages. *Brit. J. Radiol.*, 1926, *31*, 119–149.
12. Manges, W. F. Bronchial obstruction, partial or complete, as shown by the roentgen-ray examination. *Proc. Inter-State Postgraduate Medical Assembly of North America.* 1931, 367–372.
13. Sante, L. R. Quoted by Bowen, Ref. 2.
14. Scheffey, L. C., Jones, H. W., and Clerf, L. H. Postoperative collapse of the lung (atelectasis) in gynecologic cases. *Am. J. Obst. & Gynec.*, 1930, *19*, 795–806.
15. Sproull, J. Collapse of the lung occurring in pulmonary tuberculosis. Am. J. Roentgenol. & Rad. Therapy, 1928, *20*, 419–423.

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MULTIPLE ANEURYSMS OF THE SMALLER BRANCHES OF THE PULMONARY ARTERY*

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THE rarity of pulmonary aneurysms is attested by the infrequency of their discovery in large autopsy series. Their importance lies almost entirely in the field of differential diagnosis and prognosis.

When the rather common, small, vascular dilatations occurring in connection with pulmonary cavitation are excluded, the total number of aneurysms reported falls well below one hundred. Moench[9] and Costa,[4] in autopsy series of 10,000 and 20,000 cases respectively, each report one case. In reporting his case Costa gave an excellent review of the literature, and collected 73 cases.

More recently Wahl and Gard[13] collected those cases reported since the publication of Posselt's[10] summary.

In the existing material it is found that a great majority (85 per cent) of the aneurysms involve the main trunk, and most of the remaining involve the major branches. Less than 10 per cent of the entire group involve the smaller branches, and it is to this latter group that we wish to add one case.

CASE REPORT

Female, aged fifty. Father died of chronic alcoholism at the age of forty-seven. Mother died of coronary thrombosis at the age of sixty-eight. One brother died a cardiac death at the age of forty-two. Three sisters living and well.

The patient was first seen because of severe anemia which apparently resulted from recurrent epistaxis. Nosebleeds had first made their appearance at the age of thirty-nine, and continued off and on until the patient's death. At one time the anemia became so marked that transfusion was found necessary. The hemorrhages resulted from ulcerations of the nasal septum associated with delay in formation and retraction of the clot.

At the age of forty-nine, the patient suffered a cerebral vascular accident from which she recovered, except for the loss of accommodation of the left eye and accompanying diplopia.

Following this episode she was apparently well for six months, at which time gastric distress developed. This was most marked after eating and was accompanied by nausea, occasional vomiting, occult blood in the stools and steady drop in hemoglobin, from 72 per cent to 49 per cent (Dare) within two weeks. Increasing dyspnea and tachycardia were present during this period. It was at this stage of the illness, November 12, 1931, that the patient consented to enter the hospital for further study and observation.

Physical examination on entrance revealed a frail, pallid woman whose sclerae and skin gave a suggestion of a subicteric tint. Aside from the loss of accommodation in the left eye, examination of the head was negative.

The heart sounds were soft, pulse rapid and soft. Both sides of the chest showed evidence of a small pleural effusion.

The abdomen was scaphoid, no masses were felt. The extremities were negative aside from moderate wasting and loss of muscular tonicity. Electrocardiographic studies by Dr. Roy G. Pfotzer revealed a simple tachycardia. Blood studies revealed the picture of a secondary anemia. Urinary findings were normal. Stools gave strong occult blood reactions. The Wassermann and Kahn reactions were negative.

A roentgen examination of the chest revealed the appearance shown in Figure 1. The conclusion at this time was that the patient showed evidence of metastatic pulmonary malignancy with accompanying small bilateral effusion.

It was felt that a search for the primary lesion should begin with the gastrointestinal tract. Plans were accordingly made for a gastrointestinal study on the following day. However, on the afternoon of admission, and before any further examination could be completed, the patient developed symptoms of coronary thrombosis: intense precordial pain, extreme apprehension, a sharply falling diastolic pressure, oliguria and albuminuria.

During the following three days the diastolic

*From the X-Ray Department of the Millard Fillmore Hospital, Buffalo.

pressure dropped from 100 to 40 mm. Hg. On the fourth day the patient suffered an exacerbation of her symptoms and died.

An autopsy was performed three hours after death by Dr. Margaret Warwick.

The body was that of a well-developed, but very poorly nourished adult, middle-aged female. Pathologic lesions were found only in the

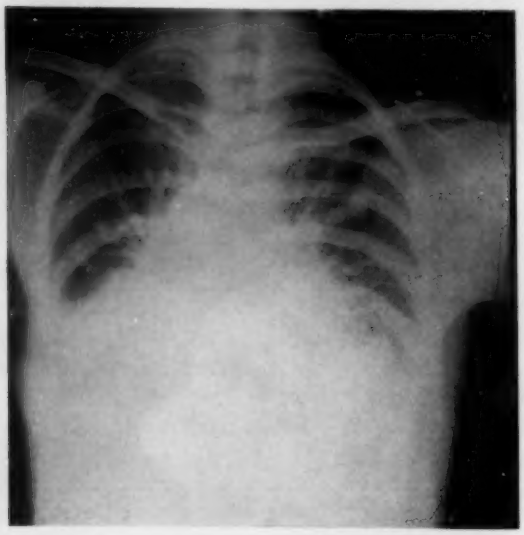

Fig. 1. The presence of rounded shadows in the right upper lung field and evidence of bilateral pleural effusion led to a diagnosis of pulmonary metastases.

lungs, pleura and heart. The head was not opened. All other parts of the body showed nothing of interest.

As soon as the left pleural cavity was opened, there was a gush of blood from between the cut ribs, as if the cavity were filled with fluid blood under pressure. In the lower part of the cavity were several large masses of dark, clotted blood. In the base of the lung was a dark-colored, rounded mass measuring about 5 cm. in diameter and bound to the upper side of the diaphragm by very firm, fibrous adhesions which were broken with difficulty, and which served to form a firm connection between the lung and the diaphragm. In one side of this mass there was a laceration from which protruded large pieces of clotted blood. This evidently represented the source of the blood in the pleural cavity but, at the time of death, the opening was effectively plugged by blood clots. This mass seemed to arise from the substance of the lung, and must have been present for some time to have been so firmly adherent to the diaphragm.

The left lung was slightly smaller than usual and without the usual content of air. It appears to have been definitely compressed by the pressure of the blood in the pleural cavity. The mass in the base was found to consist of a thin-walled sac filled with both fluid and clotted blood, arising from the lung tissue which surrounded it on one side, and on the other bound tightly to the diaphragm by firm fibrous adhesions. In one side was a rent measuring about 3 cm. in length and effectively plugged by large blood clots. The inner surface was smooth and shining and with no clotted blood adherent to the wall, suggesting that the clots, which it contained, were of recent formation, not later than the time of death. Leading out of the upper side of the sac was a small artery, which proved to be a branch of the pulmonary artery. Contrary to the usual appearance, this small artery was slightly wider at the periphery of the lung than at the hilus. At its junction with the sac, it enlarged very abruptly and became the sac. It was evident, then, that this was an aneurysm of one of the branches of the pulmonary artery, which was situated in the periphery of the lung and which must have gradually increased in size until it finally ruptured and caused a fatal hemorrhage into the pleural cavity. That this rupture was deferred as long as it was, was probably due to the protection of the diaphragm which limited its outward expansion and, by the formation of adhesions, kept it firmly fixed and immobile. Microscopic sections show only a very thin arterial wall with no adherent clotted blood. The small arteriole branches, which were in the surrounding lung tissue, were larger than usual and moderately tortuous, but the walls were not thinner than usual. The remainder of the lung showed nothing of interest.

In the right pleural cavity there was a large amount of clear, straw-colored fluid but no adhesions were found. In the right lung there was nothing of interest except in the upper branches of the pulmonary artery. Here in the upper lobe were several small dilatations of the arterial walls, measuring up to 2 cm. in diameter. These were all filled with clotted blood which was easily shelled out, leaving smooth, shining surfaces. These were evidently tiny aneurysms of the vessel similar to the one found in the base of the left lung, but better protected from dan-

gerous dilatation by the lung tissue which entirely surrounded them. Curiously enough, all of these multiple aneurysms were found in the peripheral branches of the pulmonary artery where the walls are usually thin, but where there is little arterial tension. They suggest congenital defects in the small arterial walls, which gradually increased in size with the years until one, less protected by lung tissue than the rest, ruptured and caused a fatal hemorrhage. The heart was not enlarged although there was a slight thickening of the wall of the left ventricle, in which there were numerous large patches of fibrous tissue in the muscle and, in some areas, the suggestion of some softening. The coronary arteries show a definite thickening of the wall with numerous thick, yellow plaques on the intima, but with no apparent narrowing of the lumina or the formation of thrombi. Microscopic sections of the wall of the left ventricle showed a diffuse increase in connective tissue. Large areas of muscle fibers entirely replaced by dense connective tissue with no accompanying leucocytic infiltration were present. In one area, however, there was a different picture. Here there were large numbers of polymorphonuclear leucocytes between and around the muscle cells indicating the inflammatory process following a small recent infarction of the heart muscle even though no thrombosed vessel was recognized in the gross examination. The lesions in the heart seem to be entirely dependent upon the sclerosis of the coronary arteries and to have no relationship to the condition found in the lungs which gave rise to the fatal accident which was the immediate cause of death.

DISCUSSION

The case just presented represents the most unusual and, from an etiologic standpoint, the most interesting of all pulmonary aneurysms. Those dilatations occurring in the hilar region and involving the main trunk or major branches are in the vast majority of instances due either to syphilis or some cardiovascular anomaly such as a patent ductus arteriosus.[1,4,7,8,9,10,13,14]

The causes of the more peripherally located aneurysms are not so well defined.

We have been able to find reports of 11 cases which have more or less resemblance to the one at hand. These apparently fall into two groups. The first and larger group includes the mycotic aneurysms (Humphry,[6] Beattie and Hall,[2] Trevor,[12] Sherman and Roman[11]). In the second group the aneurysms are of unknown etiology (Churton,[3] Fern,[5] Wilkens[15]). Some confusion exists in the differentiation of these two types.

In reading the autopsy protocols of some of the cases in the first group, one is struck by the possibility of pre-existing aneurysms, the presence of which was magnified by superimposed infection.

The case reported by Trevor exemplifies this point:

> A married female, aged twenty-four, was admitted December 29, 1909, and died January 15, 1910. She was well until two years before admission when she contracted dysentery. Eight months before admission she had influenza complicated by a right-sided pleurisy and hemoptysis. She had been ill since that time but was able to be about until three weeks before admission when swelling of the legs and abdomen forced her to bed. She had had a child fifteen months before entrance. Upon admission the patient was anemic. The pulse was rapid, regular and collapsing markedly. The second pulmonic sound was loud. The spleen was enlarged to below the umbilicus, hard and tender. The liver was tender, not enlarged. The presence of oral sepsis was noted. Throughout the period in the hospital the patient ran an irregular temperature with profuse sweats and occasional chills. Two weeks before death a positive streptococcus blood culture was obtained.
>
> *At autopsy:* Pleural adhesions were found in both bases and the uninvolved pleural cavities contained 500 c.c. of free fluid. Both lungs were firm from edema and chronic venous engorgement. Through both lungs were found multiple aneurysms of the branches of the pulmonary artery. In the right lung six were present, the largest in the base was the size of a small tangerine. The aneurysms were smooth walled and filled with soft post-mortem clot. Some yellow, friable, ante-mortem clot was present which resembled in color the vegetations found on the pulmonary valve.
>
> In the left lung three small aneurysms were found, the largest of which was the size of a marble. Vegetations were found on the pulmonary valve and these extended out along the left main branch of the pulmonary artery. The aortic valve showed two smaller vegetations. Pericardial fluid was increased. The heart weighed 15 ounces and presented a marked prominence and bulging of the conus of the right ventricle. Both ventricles, but particularly the right, were dilated and the walls were hypertrophied.

The aorta was smooth and showed only early atheromata.

No aneurysms were found elsewhere in the body.

The spleen was free from infarcts.

Microscopic examination showed streptococci in the vegetations but none in the walls of the aneurysms.

It would seem that with such findings the aneurysms may have been present before the onset of the fatal bacterial endocarditis.

The cases described by Humphry, and by Beattie and Hall seem to be true examples of embolic or mycotic aneurysms although here again the possibility of infection superimposed on a pre-existing vascular lesion cannot be completely eliminated.

In Humphry's case an eighteen-year-old boy entered the hospital July, 1909, and died May, 1910, of suffocative hemoptysis. An ante-mortem diagnosis of infectious endocarditis with possible accompanying congenital defect was made. At autopsy aneurysms were found in the right lung, the sacs measured from one-half to three-quarters of an inch in diameter and were directly continuous with the artery. The inner walls of the sacs were rough and irregular showing shreds of adherent clot. The outer wall was thickened. In some instances the sac was found at the apex of a wedge-shaped infarct.

No aneurysms were found in the left lung. The heart showed a patent foramen ovale and patent interventricular septum. This latter created a defect between the conus of the aorta and that of the pulmonary artery. Adherent about this aperture on the pulmonary side were several small, fibrous tags, one larger than the rest and projecting into the pulmonary artery. The author felt that embolism occurred mainly in the right lung because of a large primary clot going into the right main branch of the pulmonary artery and that secondary spread had occurred from this point.

Beattie and Hall report the case of a male, aged twenty-one, who after apparent recovery from an attack of femoral thrombosis developed "chills," cough and hemoptysis accompanied by pain in the left side.

During the observation period the patient ran a low grade temperature with rigors followed by hemoptysis at irregular intervals. He died of suffocative hemoptysis approximately six months after the onset of his illness. Autopsy revealed multiple aneurysms in both lungs. One sac in the upper right lobe had ruptured into a bronchus resulting in death. Organized thrombi were found in some of the pulmonary vessels, and in the cavity of the right ventricle an organized thrombus the size of a pea was found.

In reviewing their case and the literature the authors state:

"Embolic aneurysms of the pulmonary arteries are exceedingly rare. Inquiries as to the existence of specimens made from curators of twenty-one museums of the United Kingdom and a search through the literature of the subject have enabled us to collect five more cases."

They sum up the cases of mycotic aneurysms in the following manner: (1) All occurred in young adult life, eighteen to twenty-four years. (2) Duration was from six months to one year from first onset. (3) In 2 cases only one lung was affected. In the others, the right lung contained larger and more numerous aneurysms than the left. (4) Thrombi were found in 2 cases. Shreds of thrombi in the others. (5) The heart was affected in 3 cases. (6) In 2 cases the aneurysms ruptured into the lung causing suffocation. (7) Recurrent hemoptysis such as is seen in infarction mentioned only twice.

The case reported by Sherman and Roman appears to fall in this group of mycotic aneurysms.

As has been intimated we are not entirely convinced that the aneurysms grouped with the embolic or mycotic type should be so placed.

The frequency of pulmonary infarction with both septic and sterile emboli is so greatly out of proportion to the number of reported peripheral pulmonary aneurysms that its possible causative relationship should be questioned.

Furthermore, in the protocols of the reported cases only one vascular trunk has been found leading into the aneurysms. We see no reason why destructive changes should not open additional vessels. On the other hand, the tendency of infection to become superimposed on a vascular anomaly is well recognized. Finally, in the present case no evidence of infarction or infection was present in the lungs.

We feel, therefore, that this case cannot in any sense be grouped with the mycotic aneurysms. The etiology is undetermined.

Increased pulmonary pressure associated with a congenital defect in the vessel wall may be the explanation. The cases reported by Churton and by Wilkens both represented congenital heart lesions of sufficient severity to account for increased pulmonary pressure.

The pathological anatomy of the condition was clearly described in the first report which we have found.

"Mr. Fern of Derby has recorded (*Lancet*, February 6, 1848) the case of a patient who died from hemoptysis in whom an aneurysmal sac the size of a nutmeg was found jutting into a tubular extremity on the upper lobe of the left lung. The parietes of the sac were thin and did not contain any fibrinous layers, a vessel the size of a crow quill leading from a considerable trunk of the pulmonary artery was distinctly traceable into the sac."

A clinical syndrome is rather difficult to construct from the small group of reported cases. The patients are usually young and show a tendency to bleeding from the nasal or oral mucous membranes. An associated heart lesion may be present. Epistaxis or hemoptysis leads to anemia which, as in our case, may become quite severe, and superimposed infection would add its accompaniments of chills, fever and leucocytosis. Death results either from hemorrhage or infection.

The duration of the condition is not definitely known. Wilkens' case was followed over a period of six years.

The condition should certainly be differentiated both clinically and pathologically from the more common aneurysms of the main trunk and major branches. This latter group has a fairly definite symptomatology of heart disease often with polycythemia and a mediastinal tumor which produces varying degrees of pressure symptoms or is visualized in the roentgen examination.

DIAGNOSIS

The rarity of peripheral aneurysms militates against their clinical recognition, first, because they are rarely, if ever, thought of, and second, because of the lack of a firmly established symptomatology. Three of the cases which we have encountered have had roentgen studies made.

In the case of Sherman and Roman the roentgen findings were indeterminate. In Wilkens' case the findings were interpreted as tuberculosis, while in the case which we present the findings were interpreted as pulmonary metastases.

A review of the films with the post-mortem findings in mind make it clear that such an error may be avoided in the future. A close study of Figure 1 will show that each of the rounded densities in the upper right lung field shows a definite vascular connection with the hilus. This is the one characteristic differentiating point.

Roentgenoscopic examination might or might not reveal pulsation in the sacs, depending on their size and the state of their contents.

Failing to demonstrate these vascular connections one would be forced to a consideration of: pulmonary metastases, hydatid cysts, discrete tuberculous deposits, gummatous pulmonary lues or the unusual multiple nodular type of primary pulmonary carcinoma.

The differentiation on combined roentgenographic and clinical grounds should not be difficult if the possibility of the condition is kept in mind.

SUMMARY

A case of multiple aneurysms of the terminal branches of the pulmonary artery has been presented. A brief review of the literature reveals that such dilatations may arise either as mycotic aneurysms or upon the basis of congenital defects. The case presented falls in this latter group. It is felt that these types of aneurysms should be differentiated from those involving the major trunks. An attempt is made to clarify a somewhat indefinite symptomatology and a differential point in roentgenographic diagnosis is mentioned.

REFERENCES

1. Arrillaga, F. C. Aneurysm of the pulmonary artery with cyanosis of the face ("black cardiacs"). *Bull. et mém. Soc. méd. d. hôp. de Par.*, 1924, *48*, 1230–1235.
2. Beattie, J. M., and Hall, A. J. Multiple aneurysms of the pulmonary arteries following thrombosis of the veins of leg. Death from rupture of aneurysm into the lung. *Proc. Roy. Soc. Med.*, 1911–1912, *5* (*Path. Sect.*), 147.
3. Churton, H. Multiple aneurysms of the pulmonary artery. *Brit. M. J.*, 1897, 1223.
4. Costa, A. Morfologia e patogenesi degli aneurismi dell'arteria polmonare. *Arch. di pat. et clin. med.*, 1929, *8*, 257–292.
5. Fern. Quoted by Chevers, N. *Lond. Med. Gaz.*, 1848, 42.
6. Humphry, L. Multiple embolic aneurysms of the pulmonary artery. *J. Path. & Bacteriol.*, 1912–1913, *17*, 212–216.
7. Leconte, M., and Bordet, E. Aneurysm of the pulmonary artery. *Bull. et mém. Soc. méd. d. hôp. de Par.*, 1924, *48*, 353–358.
8. Loveland, B. C. Aneurism of the pulmonary artery. *Med. Rec.*, 1901, *59*, 349–351.
9. Moench, G. L. Aneurysmal dilatation of the pulmonary artery with patent ductus arteriosus. *J. Am. M. Ass.*, 1924, *82*, 1672–1673.
10. Posselt, A. Die Erkrankungen der Lungenschlagader. *Ergebn. d. allg. Path. u. path. Anat.*, 1909, *13*, 298–526.
11. Sherman, D. H., and Roman, B. A case of multiple aneurysms of the branches of the pulmonary artery. *Buffalo Gen. Hosp. Bull.*, 1926, Vol. *4*.
12. Trevor, R. S. A case of multiple mycotic aneurysms of the branches of the pulmonary artery within the lung. *Proc. Roy. Soc. Med.*, 1911–1912, *5*, (*Path. Sect.*), 155–158.
13. Wahl, H. R., and Gard, Raymond L. Aneurism of the pulmonary artery. *Surg., Gynec. & Obst.*, 1931, *52*, 1129–1135.
14. Warthin, A. S. Syphilis of the pulmonary artery. *Am. J. Syph.*, 1917, *1*, 693.
15. Wilkens, G. D. A case of multiple pulmonary aneurysms. *Beitr. z. Klin. d. Tuberk.*, 1917, *38*, 1–10.

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THE TYPE AND LOCATION OF ROENTGEN SHADOWS IN THE DIAGNOSIS OF CHRONIC PULMONARY TUBERCULOSIS

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THE roentgenologist in most instances makes a correct diagnosis of pulmonary tuberculosis as checked by clinical and necropsy findings. In fact, he is often the first to detect the disease. This accuracy in diagnosis exists despite the fact that roentgenologists disagree in their appraisal of the shadows. Some hold that the shadows are pathognomonic, others that they are characteristic, and still others that they are merely suggestive of the disease, while only a few briefly refer to their location as an aid in diagnosis. We shall attempt to evaluate these conflicting views because they lessen the clinical value of the roentgen ray and are confusing to the student.

TYPE OF SHADOW IN DIAGNOSIS

Cole,[4] one of the earlier authorities, says:

> I do not claim to show the microscopic (tubercles). But it is the intermediate tubercles, the smallest ones that are clearly discernible by the naked eye on cross section . . . that show distinctly in a radiogram having sufficient detail. It is on these tubercles that the positive diagnosis of incipient pulmonary tuberculosis by the x-rays depends.

Manges[7] in discussion states:

> I do not care what the stage of the disease, except the very, very early stage, or when exudation is excessive, you can always recognize the tubercle shadows, and that shadow is essential to the diagnosis of pulmonary tuberculosis. It does not matter whether the tubercles are discrete or confluent; whether they involve a part or the whole of a lobe.

Dunham[5] is equally definite:

> It is the characteristic densities of a fan that are pathognomonic of tuberculosis and not the fan itself.

Caulfeild and Richards[3] define first degree minimal involvement in the following words:

> . . . lessened radiability as shown in the form of light mottling, haziness or flocculent opacities, confined to one area or a cluster of contiguous areas not exceeding one inch in cross section. This is intended to represent the smallest lesion which can be positively identified as a definite tuberculous lesion.

Kraetzer[6] commits himself as follows:

> . . . suffice it to say that the only pathognomonic x-ray sign of early tuberculosis is the characteristic shadow of parenchymatous infiltration.

If the mottled shadows of tuberculosis were characteristic, one should be able to differentiate them from the mottled shadows of chronic non-tuberculous infections. The two are indistinguishable, for the mottled shadows of the chronic non-tuberculous infections confined to the upper third of the lung field are erroneously interpreted as tuberculosis, and conversely, the mottled shadows of tuberculosis when confined to the lower third are confused with those of the chronic non-tuberculous infections.

Dunham[5] discussing basal lesions says:

> They are very difficult to diagnose and I always wait for the bacilli to be found before making a definite diagnosis.

We, too, were unable to distinguish the mottled shadows of tuberculosis from those of chronic non-tuberculous infections in a series of 74 cases, 31 proved tuberculous and 43 non-tuberculous, where the disease was unilateral and confined to the lower third of the lung. In 20 cases of chronic pulmonary tuberculosis and 6 cases of chronic non-tuberculous infections coming to necropsy, we attempted to correlate the lesions with their respective shadows. Roentgenograms were taken frequently during the course of the disease, and after

death with the lungs in situ and after they were removed from the body and inflated. We found no appreciable difference between the mottled shadows of tuberculosis and those of the chronic non-tuberculous infections, even by the aid of a magnifying glass.

Miliary tuberculosis affords the crucial test to determine whether the shadows are pathognomonic. Here the mottling is fine, discrete and sharply defined and presents optimal conditions for the interpretation of underlying pathological changes. Yet the shadows of miliary tuberculosis cannot be differentiated from those of miliary carcinoma or miliary silicosis.

The histological character of the tuberculous lesion does not vary with its position in the lung. The claims of certain observers that the shadows are characteristic in one part of the lung field and not in another is a tacit admission that they are not characteristic.

The pathologist frequently cannot differentiate chronic pulmonary diseases on macroscopic examination. It is therefore even less likely that the roentgenologist should do so from a study of their shadows for they merely represent airless portions of the lung resulting from disease or atelectasis.

In previous communications [1,2] attention was directed to the mutation of pulmonary shadows incident to the type of respiration. On costal breathing the shadows may appear mottled and on diaphragmatic breathing the same shadows may be homogeneous, additional evidence that tuberculous lesions do not cast distinctive shadows.

LOCATION OF SHADOWS IN DIAGNOSIS

Clinical and necropsy studies in adults reveal that tuberculosis is responsible for at least 90 per cent of all chronic lesions localized in the upper third of the lung. The incidence is higher when the lesion is confined to the apex of one lung, and still higher (practically without exception) when limited to the apices of both lungs. Conversely, the incidence of non-tuberculous lesions in the lower third of the lung is more than 90 per cent and when the lesions are confined to the bases of both lungs they are almost invariably non-tuberculous. Tuberculous lesions localized in this region are uncommon; even among patients in sanatoria the incidence is less than 3 per cent.*

The site of predilection of these diseases adequately explains the accuracy of roentgen diagnosis. Thus the probable diagnosis is tuberculosis when the shadows, irrespective of type, are confined to the upper third of the lung field, and non-tuberculous infection when confined to the lower third. Tuberculosis will almost invariably be the correct diagnosis when the shadows are limited to the summit of both lung fields, and non-tuberculous disease when confined to the bases of both lung fields. In those relatively rare instances where the non-tuberculous infections are confined to the upper third of the lung, their mottled shadows are usually mistaken for those of tuberculosis. Location and the lack of distinctive shadows are unquestionably the source of error. The same holds true for tuberculous lesions when confined to the lower third of the lung.

The central third of the lung is common ground for tuberculosis and the non-tuberculous infections, the former predominating, more particularly when bilateral.* Consequently in this region there will be numerous errors in roentgen diagnosis based solely on location. That the type of shadow does not reduce the number of errors refutes the theory of characteristic shadows.

The roentgen diagnosis of tuberculosis in young children is admittedly more difficult than in adults, although the shadows are the same in both instances. The difficulty may be attributed to the fact that in children there is no site of predilection for the disease.

* So far as we can determine, there are no available statistics in regard to the incidence of tuberculous and non-tuberculous disease in the central and lower third of the lung. The percentages here given are approximate and based on studies at the Ray Brook Sanatorium and at the Cornell Medical Division of Bellevue Hospital.

The uniform distribution of the mottling throughout both lung fields in miliary tuberculosis eliminates location as a diagnostic aid. Here the diagnosis rests solely on the type of shadow, which is as typical as any to be found in tuberculosis. That the shadows fail to identify the condition should be conclusive proof that they are not pathognomonic.

Even where the shadows are more or less widely distributed in one or both lung fields, the roentgenologist often makes the correct diagnosis from impressions which he bases on experience, but cannot definitely define. We have analyzed many of these interpretations and have concluded that the underlying factor is location. Apparently his aim is to determine the site of the initial clinical lesion, and he often argues that this lesion originated where the shadows are most dense and numerous and makes his diagnosis on this information.

No claim is made that the shadows indicative of antrum formation are characteristic of tuberculosis, yet in diagnosis they are as important as the moderately coarse and fine mottling. Their significance, like that of the mottled shadows, depends not on their type, but on their location.

Our studies indicate that the roentgen shadows in pulmonary tuberculosis are not distinctive. The view that they are characteristic may result in the disregard of other valuable procedures and lead to unnecessary errors in diagnosis. This view is also largely responsible for the confusion in roentgen diagnosis and supports the prevailing idea that the subject is difficult.

The basis of the roentgen diagnosis of pulmonary tuberculosis is the location of the shadows. This is attested by the definite correlation between the accuracy of roentgen diagnosis and the location of the shadows, and students so instructed readily master the subject.

REFERENCES

1. Bray, H. A. Mutation of pulmonary shadows due to type of breathing. Am. J. Roentgenol., 1922, *9*, 628–631.
2. Bray, H. A. Further remarks on mutation of pulmonary shadows due to type of breathing. *Am. Rev. Tuberc.*, 1925, *10*, 649–655.
3. Caulfeild, A. H. W., and Richards, G. E. The systematic study and classification of stereograms of the chest. *Canad. M. J.*, 1927, *17*, 794–797.
4. Cole, L. G. The radiographic diagnosis and classification of early pulmonary tuberculosis. *Am. J. M. Sc.*, 1910, *140*, 29–53.
5. Dunham, H. K. X-ray examination of the chest and an x-ray classification of pulmonary tuberculosis. Am. J. Roentgenol., 1921, *8*, 427–444.
6. Kraetzer, A. F. Procedure in examination of the lungs. Oxford Medical publications, 1930.
7. Manges, W. F. Discussion of paper by Dunham, H. K. Am. J. Roentgenol., 1917, *4*, 289–290.

THE CLINICAL, ROENTGENOLOGICAL AND OPERATIVE FINDINGS IN 158 CASES OF MASTOIDITIS*

A DESCRIPTION OF A NEW SIGN OF EARLY CELL NECROSIS

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MANY cases of mastoiditis have been reported, operative and roentgenological technique described, and findings, treatment and prognosis dwelt upon. This study of the comparison of clinical, roentgenological and operative findings was undertaken to determine the significance of the various clinical findings in terms of the pathology present and the value and accuracy of the roentgenographic examination. This paper is a report of 158 cases of mastoiditis which have come to operation within a short time after being roentgenographed and in which we have complete data in regard to the clinical and operative findings.

The incidence and severity of mastoiditis seemed to be in direct ratio to the primary infection. In the spring of 1929 we saw a series of cases following an influenza epidemic. These cases did not present the fulminating type of mastoiditis, but a large percentage required surgery. In the winter of 1933, following another epidemic of influenza, we again saw a large number of cases of mastoiditis. A greater percentage of these required operation than in the former epidemic. Also, these cases were of a rapidly developing type. Even in cases seen with an early otitis media in which vigorous treatment was instituted, the majority went on to a mastoiditis requiring surgery.

Mastoidectomy was performed upon patients who presented the usual clinical signs of mastoiditis and roentgen findings of cellular necrosis. Cases that presented the usual clinical and laboratory findings of mastoiditis in which the roentgen examination showed opacity of the cells, but not cellular necrosis, were usually given expectant treatment. If the laboratory and clinical findings did not abate, the patients were usually operated on whether re-examination showed cellular necrosis or not. Often roentgenograms taken twenty-four to forty-eight hours after the original films would show necrosis of the cells. In the cases of the fulminating type mastoidectomy was performed even if the roentgenograms failed to show cellular necrosis, and frequently necrosis was found at operation.

Of the 158 cases, 131 were operated on within twenty-four hours after taking the roentgenogram; in 14 cases one day intervened between the roentgenographic examination and the operation; in 7 cases two days; in 6 cases three days; and, in one case of chronic mastoiditis showing cell destruction on the film and at operation, there was an interval of thirteen days.

The age incidence in this group is brought out by the following tabulation:

3 to 6 months	3
6 to 9 months	3
9 to 12 months	3
12 to 15 months	6
15 to 18 months	4
1½ to 3 years	4
3 to 6 years	21
6 to 10 years	30
10 to 15 years	13
15 to 20 years	18
20 to 30 years	28
30 to 40 years	10
40 to 50 years	9
50 to 60 years	3
60 to 70 years	3

There were 75 males and 83 females. The right ear was affected in 83 of the cases and the left in 75. It will be noted that the side involved and the incidence of males and females affected were about equal. The greatest number of cases were in the groups under ten years of age.

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The majority of the cases in our series were of acute mastoiditis. The type of mastoiditis and associated complications are shown by the following table:

Acute	147
(with nephritis—2	
(with multiple sclerosis—1	
Acute complicated	
With fracture skull	1
With cerebellar abscess	2
Lateral sinus thrombosis	7
Subacute	2
Chronic	6
(with cerebral abscess and	
(meningitis—1	

In general, the duration of the symptoms of mastoiditis obtained from the history of the patients or relatives was short, mostly under one week and the vast majority under two weeks. In considering the duration of the symptoms, we do not mean the prodromal symptoms or the presence of otitis media, but as nearly as can be determined the time of the actual existence of the mastoiditis.

The characteristic symptoms of mastoiditis were present in practically all of the cases. Protrusion of the auricle was evident in 37 of the cases, due either to edema or subperiosteal abscess formation, or both. Pain over the mastoid was complained of in 134 of the cases. Tenderness was also a rather constant factor, being present over the entire process in 123 cases, the antrum in 20, the tip in 15 and the zygoma in 2. Edema, although less common than might be expected, was present over the process in 90 cases and over the zygomatic region in 4. This sign is not infallible and when apparently present, gland enlargement due to furunculosis, scalp infection, otitis media, or other causes must be excluded. Here the roentgen examination plays a valuable part. Edema or sagging of the auricular canal was found in 41 cases. This drooping was uniformly a helpful sign, the most difficult differential point being the complication of furunculosis of the canal.

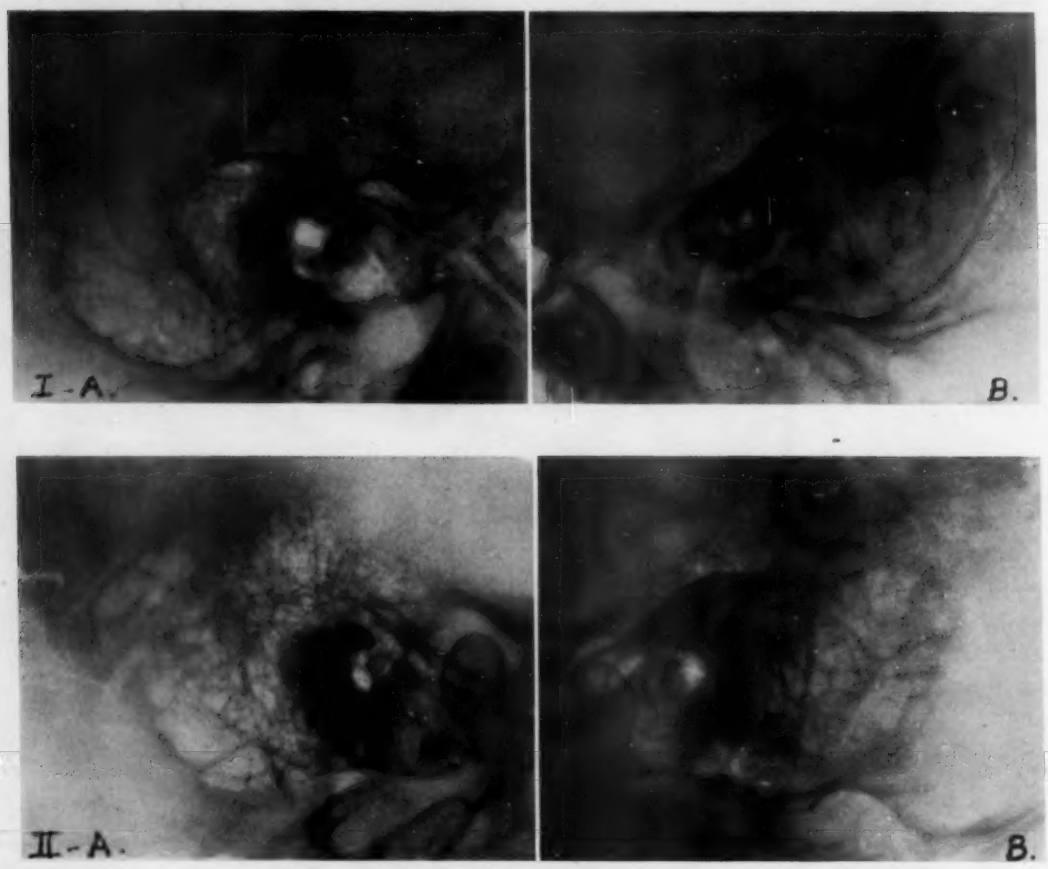
Albuminuria was of fairly frequent occurrence and usually cleared up after intervention on the mastoid.

Cultures were taken from the mastoid at the time of the operation in all but 38 cases. For accuracy in reports it would seem that smear and culture from the ear when otitis is present plus a mastoid culture at the time of the operation would give added information, and such procedure has been done in some of the later cases. The cultures are valuable in noting the type of infection, particularly during epidemics following such diseases as measles, scarlet fever or influenza, and also when subsequent blood stream infection takes place. The following table shows the types of organisms in the order of their frequency:

Streptococcus	55
Streptococcus and staphylococcus	2
Streptococcus and pneumococcus	1
Pneumococcus	22
No growth	16
Staphylococcus	12
Diplococcus and bacillus	11
Micrococcus catarrhalis	1

Three deaths, a mortality rate of 1.9 per cent, occurred among these 158 cases, 2 of which were due to lateral sinus thrombosis and one to cerebellar abscess. The latter patient had a left mastoidectomy. Twenty days after being dismissed from the hospital he returned and a diagnosis of brain abscess was made. Craniotomy was performed, but the patient died four days later. Autopsy showed a cerebellar abscess of the left side. The other two deaths were due to lateral sinus thrombosis with septicemia. The second of these patients had been dismissed following the mastoidectomy. She returned eighteen days later with a lateral sinus thrombosis and died in five days.

The 7 cases of lateral sinus thrombosis presented the more or less typical signs of this complication. When the prodromal symptoms of toxicity, chills, septic rise in temperature, and other signs point to a lateral sinus infection, operative procedure should be instituted early. Ligation of the



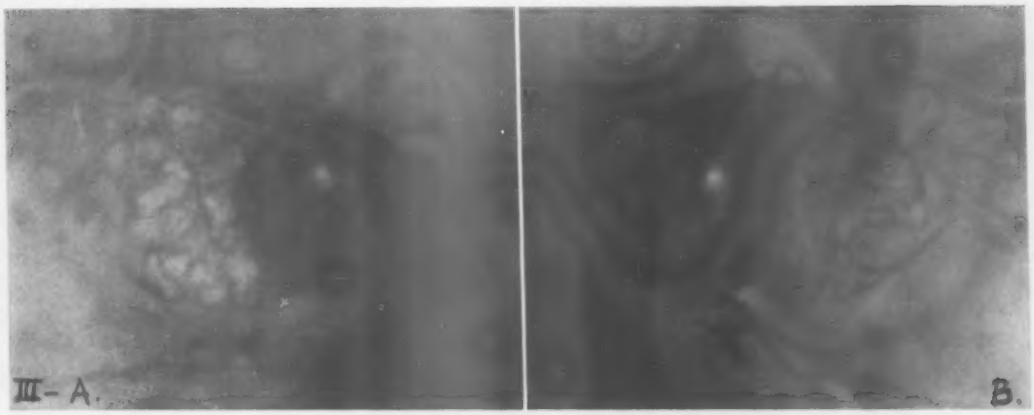
Figs. 1, 2, 3 and 4. Roentgenograms showing the sign of early cell necrosis. Those marked A are the normal sides for comparison with the affected sides labelled B. Note in the involved sides (B) that the cell outlines appear slightly widened, density of cell wall appears to be increased, edge of cell wall shows a fine

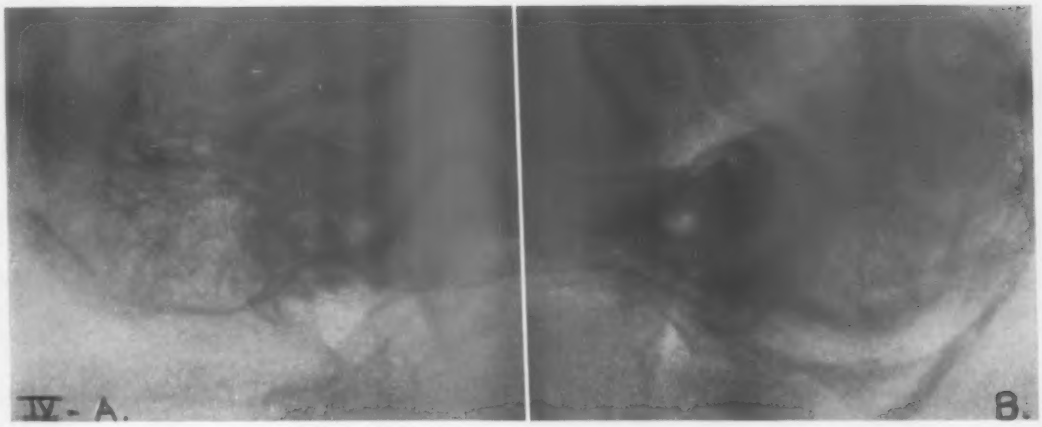
jugular vein and opening of the sinus was the procedure used. The value of early and repeated blood transfusions in cases of lateral sinus infection and septicemia cannot be overestimated. The patients in this series were given the combined surgical treatment plus the transfusions.

The roentgenogram cannot indicate lateral sinus infection or thrombosis, but it is most valuable in sinus location prior to mastoidectomy. Then, during the operation the sinus wall can be well outlined in bony contour, thus making operative procedure easier later on if a sinus infection should develop and exposure become necessary.

Bilateral stereoscopic films in the Law position were the views taken routinely. In the presence of an otitis externa, complicating furunculosis of the canal, where there was a question of mastoid involvement, and in which the Law position showed only a diffuse haziness, views in the Granger-Arcelin position were also made. The best detail possible was obtained by using a tube with an extremely fine focal spot and the smallest cone possible. The Potter-Bucky diaphragm was employed except in cases of infants and small children where a rapid technique was required.

In studying the films the following points were noted especially, and reported to the surgeon:





fuzziness, but that the cell wall can be traced out completely, or at least could be in the original films. At operation these cases all showed necrosis of the cell walls.

1. *The type of mastoid*—whether infantile or adult. There were 130 adult and 28 infantile.

2. *The size of the cells, any unusual location of cells, and the presence of zygomatic cells.* The majority of the cases contained medium-sized cells. In the 28 cases with infantile type of mastoid, 14 were of the diploic type, the ages being:

Under 6 months	2
6 to 12 months	5
12 to 18 months	2
18 months to 5 years	5

There were 14 cases of the infantile type with small cells, the ages of the patients being:

Under 6 months	1
6 to 12 months	2
1 to 3 years	10
24 years	1

Zygomatic cells were seen on the films in 20 of the cases.

3. *The presence and degree of opacity in the mastoid antrum and cells.* There was a marked degree of opacity of the antrum and some of the cells in all but 3 in this group, pus being present in the antrum and part of the cells at operation. In 3 patients, aged four, eight and eleven months, with an infantile diploic type of mastoid, no change was discernible on comparing the two sides, but pus was found at operation. Even in these 3 cases the films were valuable in that they showed the location of the sinus. However, in the other 6 cases under one year of age definite changes were

shown by roentgenograms and confirmed at operation.

4. *Evidence of cell necrosis.* Cell necrosis was reported (*a*) if the cell walls could not be traced out in their entirety in studying the stereo films and comparing the two sides, (*b*) whenever the new sign of early cell necrosis, described later in this paper, was present, (*c*) in the presence of a positive Granger sign. In reporting necrosis the mastoid cells were divided into four groups: periantral cells; upper half of mastoid; lower half of mastoid; and zygomatic or unusual extension of the cells.

(*a*) Definite cell necrosis. One or more groups of cell walls appeared definitely necrotic on the films in 113 of the cases; 112 of these showed necrosis at operation.

Of the 20 cases showing zygomatic cells, the youngest patient being three years of age, 9 showed necrosis of these cells on the films and at operation, and one showed only opacity of the cells, but early necrosis was present at the time of the surgery two days later.

(*b*) A new sign of early cell necrosis. About three years ago in checking the surgical findings and the mastoid films immediately after the operation, it was noted that cases not showing frank cellular necrosis roentgenologically, but in which the cell walls showed the following roentgen changes, were necrotic:

(1) Cell wall would appear to be slightly widened.

(2) Density of the cell wall seemed to be slightly increased.

(3) Edge of the cell wall would show a fine fuzziness.

(4) Cell walls, however, could be traced out completely.

Since that time this sign has been carefully looked for and in this series there were 11 cases that showed the four findings of this sign in the cell walls. Ten of these showed necrosis of the cell walls at operation. In the other case the cells contained pus and the cell walls appeared to be intact (Figs. 1, 2, 3 and 4).

(*c*) Granger's sign. Four patients, aged three, eleven, seventeen and twenty-four months, showed the sign described by Granger, that is, the sinus plate could be clearly seen on the affected side and could not be visualized on the normal side. These cases showed extensive necrosis of the cells down to and involving the sinus plate at operation.

In 20 cases the cells appeared opaque and the cell walls appeared normal on the films, but at operation they showed necrosis. In 3 only a slight amount of necrosis was present around the antrum. It must be remembered that this series contains only operated mastoids. There were a large number of cases seen during this period showing opacity of the cells, but no evidence of cell destruction, and these patients made uneventful recoveries without operation.

We made a roentgenographic diagnosis of cell necrosis in 128 cases, the diagnosis being based on definite loss of cell outline in 113, on the new sign of cell necrosis in 11, and on Granger's sign in 4 cases. One hundred and twenty-six of these showed necrosis at operation. Twenty cases did not show evidence of cell necrosis on the films, but did at the time of the mastoidectomy.

5. *The position of the lateral sinus.* After a discussion with the otologist, it was decided to report in all mastoids the position of the sinus in regard to its relationship to the antrum and also in regard to its depth from the cortex. It was reported as anterior if it was in very close proximity to the antrum, as median if it passed through the middle of the mastoid process, and posterior if it was in the posterior part of the mastoid process. It was reported as superficial if it was just under the cortex, of medium depth if one or two layers of cells intervened between the sinus and the cortex, and as deep if it was located along the inner border of the mastoid.

The location of the lateral sinus in this series was as follows:

	Anterior	*Median*	*Posterior*
Superficial	19	41	10
Medium	11	33	4
Deep	3	16	6

It was not seen on either side in 11 cases. In 4 cases it was not seen on the affected side, but could be seen on the normal side.

In 8 of the cases reported as anterior and superficial its location was such that the surgeon had difficulty in exposing the antrum. The ages of these patients were:

1 year.....2
$\frac{1}{3}$ years.....1
5 years.....2
18 years.....1
25 years.....2

We were unable to detect any change in the sinus plate in the roentgenograms which would indicate whether necrosis of this plate was present, except the Granger sign in infants.

In one case the jugular bulb was shown very high in the films and it was of great value to the operator to know its anomalous location in advance.

6. *The location of the emissary vein.* The emissary vein could be seen on both sides in 31 cases, on only one side in 33 cases, and could not be visualized on either side 94 times. In 7 cases it was encountered during the operation. In 5 of these it was seen within the operative field on the roentgenograms previous to surgery.

The comparison of roentgenological and clinical findings enables the roentgenologist to render a more accurate interpretation of the films; and at the same time it aids the otologist in determining the necessity for operation. The roentgen examination is not only of assistance in determining the presence of cellular necrosis, but is also of great value in that the surgeon knows the anatomical findings previous to operation.

SUMMARY

1. The cooperation of the otologist and roentgenologist results in greater diagnostic accuracy.
2. The roentgen findings were reported according to the following outline:
   (1) Type of mastoid
   (2) Type of cells
      (*a*) Size
      (*b*) Presence of zygomatic cells
      (*c*) Any unusual extension of cells
   (3) Degree of opacity of antrum and cells
   (4) Evidence of cell necrosis
      (*a*) Definite necrosis
      (*b*) Sign of early necrosis as described in this paper
      (*c*) Presence of Granger's sign
   (5) Location of lateral sinus
      (*a*) Position in regard to distance posterior to antrum
         (1) Anterior
         (2) Median
         (3) Posterior
      (*b*) Position in regard to depth from cortex
         (1) Superficial
         (2) Medium depth
         (3) Deep
   (6) Location of emissary vein
   (7) Any unusual anatomical finding
3. Of the 158 cases, 128 showed cell necrosis roentgenologically by the loss of cell outline, presence of the new sign of cell necrosis herein described, or positive Granger sign. One hundred and twenty-six of these showed necrosis at operation. Twenty cases did not show roentgenological evidence of cell necrosis, but cell necrosis was present at operation.
4. The following roentgenological changes constitute a new sign of early cell necrosis: (*a*) cell walls appear slightly widened, (*b*) density of cell wall appears to be slightly increased, (*c*) edge of cell wall shows a fine fuzziness, (*d*) cell walls, however, can be traced out completely.

ANOMALIES OF THE SKULL IN THE NEW-BORN*

WITH SPECIAL REFERENCE TO "RELIEF" OR "LACUNA SKULL" ("LÜCKENSCHÄDEL")

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ENGSTLER,[3] in 1905, called attention to a peculiar condition occurring in the skulls of the new-born in which there were numerous parchment-like lacunae throughout the flat bones of the skull. He also called attention to the fact that this condition was usually associated with spina bifida, but stated that the findings at autopsy were not those of the ordinary hydrocephalus. He was unable to find in the pediatric literature any reference to such skull changes in a case of spina bifida.

Wieland,[14] after a careful study, came to the conclusion that Engstler's cases were only one form of bony anomaly found in the new-born. He distinguished two groups of such anomalies: first, the defects of apposition which are characterized by softened zones along the edges of the cranial bones especially the parietalia; these are the cases of "soft sutures" and are caused by mere lack of development of the skull ossification, and second, the cranial resorption defects, which while more common in the parietal areas may also include the remainder of the skull vault.

In the "soft suture" type of anomaly, the thinned, softened edges of the cranial bones occur most frequently on the edges of the parietal bones along the sagittal suture. This is probably very similar to the so-called "plastic skull" and represents a state of delayed ossification. In the plastic skull, the edges of the sutures are hard and the sutures themselves broad and gaping, representing thereby a complete, though temporary, cessation of ossification, while in the "soft suture" type, the delay in ossification has not been so complete. According to Wieland, an increase in the volume of the brain substance which occurs during the last month or two of fetal life is also an important contributing factor, while Thoma[12] feels that the constant pulsation of the brain, with its slight increase and decrease in size, acts on the already ossified parts of the skull and prevents complete ossification, just as incomplete immobilization of a long bone fracture inhibits the proper growth of callus and promotes fibrous ankylosis.

Wieland's second form of soft or lacuna skull is subdivided by Cohn[2] into two parts: first, those which occur as more or less discrete lacunae at the vertex of the skull, opposite the posterior end of the sagittal suture. These are at first membranous but later harden. They constitute about 50 per cent of Wieland's soft skulls.

Regarding the etiology of this type, there is no unanimity of opinion. Wieland thinks it is due to a great increase in the growth of the transverse arch of the skull during the latter months of pregnancy and to the fact that ossification cannot keep pace with the growth. With this view, Cohn's ideas are in sharp contradiction. He thinks that Schaeffer's[10] work on skull growth disproves Wieland's hypothesis and tends to confirm his own (Cohn's): i.e., that these defects in the vertex are caused by incomplete filling in of normal physiologic fissures,—the parietal foramen or the third fontanelle. In other words, they are a failure to pass a normal phylogenetic stage of development at this particular period. Kassowitz[6] felt that the abnormal pressure on the skull vertex at birth was sufficient to cause resorption corresponding to cerebral convolutions, but the fact that they are found in children who have been born in breech presentation, and occasionally in premature children about the time

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of their maturity makes it difficult to accept this view.

The frequent occurrence of these defects was used by Kassowitz also as an argument in favor of his opinion that fetal rickets is not an uncommon occurrence, for he believed that the basic factor in these cases was rickets. Wieland admits that children with this anomaly are just as prone to later development of rickets as are normal children but is emphatic that the two conditions can be sharply distinguished, (1) by time of onset, (2) by location of lesions, and (3) by its effect on the remaining skeletal and muscular systems. His histologic research makes him feel that lacuna skull has nothing whatever to do directly or indirectly with rickets. With this opinion most writers on this subject are in complete accord. Cohn himself feels that this is the most important contribution to the subject made by Wieland.

Second, there is the form of soft or lacuna skull in which are found long, irregular or round depressions in the skull tables. To this type of congenital anomaly Schmidt,[11] in 1910, gave the name of "relief skull." Cohn,[2] Schmidt,[11] Faust,[4] Engstler,[3] Wieland,[14] Kato,[7] and others, have noted that this type is found almost exclusively in conjunction with spina bifida with meningocele or with encephalocele. Our 3 cases were all of this type. Faust notes a special type of physiognomy in these cases, which he describes as a depression of the root of the nose, a protruding upper jaw and an old, matured expression, which he thinks is pathognomonic.

Von Recklinghausen[9] was the first to call attention to the occurrence of spina bifida and relief—or lacuna—skull in the same patient, and Heubner,[5] in 1903, also reported a case, with spina bifida and club feet. The skull showed the characteristic changes of relief skull but while the sutures were wide, the circumference of the skull was less than normal—31 cm. Von Recklinghausen's explanation was a simultaneous occurrence of cranial and spinal osseous defects together with a hydrops of the medullary groove, and in this opinion Engstler concurs.

In this type of anomaly, the skull shows digitations corresponding to the brain convolutions and has the roentgenologic appearance of increased intracranial pressure

Fig. 1. Drawing of inside of skull of Engstler's Case 6.

except that there is no widening of the sutures or bulging of the fontanelles. In Engstler's case (see Fig. 1) palpation showed a smooth skull but with somewhat enlarged fontanelles. The inside of the skull showed a net-like arrangement of bone growth, which formed arches, between which paper-thin, periosteal, almost membranous, areas appeared. The arches or ridges corresponded, for the most part, with the arterial vessels and were of about normal thickness.

Wieland and Faust explain the findings on the basis of increased intracranial pressure and believe that the encephaloceles and meningoceles that occur are in the

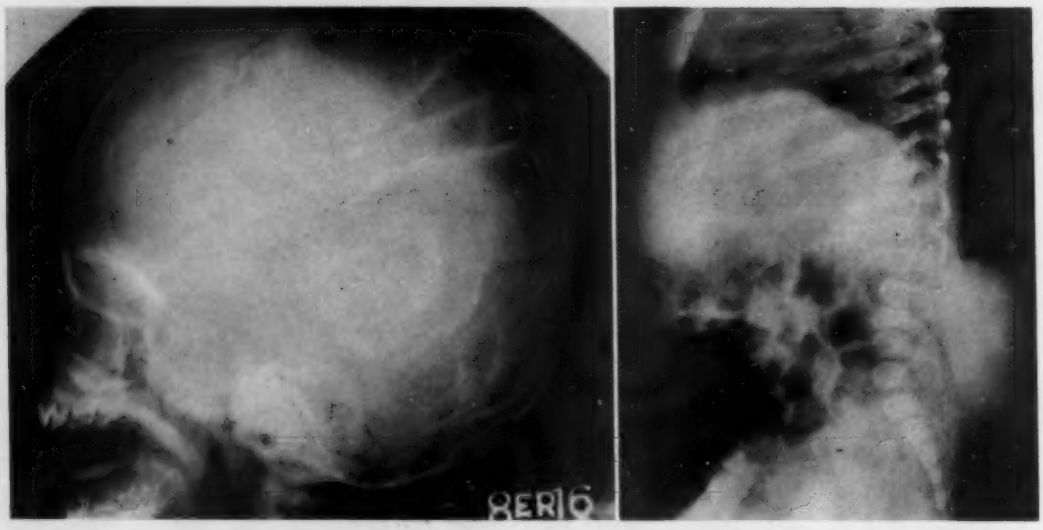

Fig. 2. Case 1. "Relief skull" and spina bifida with meningocele. Sutures open but narrow rather than wide.

nature of growth or pressure "safety valves." Lack of widening of the sutures and bulging of the fontanelles is explained by Faust by the fact that the skull is surrounded by the amniotic fluid which prevents enlargement of the skull in any single direction. Kato and Engstler deny the action of increased intracranial pressure and explain the findings on a basis of maldevelopment per se, as did von Recklinghausen, although von Recklinghausen admitted hydrops of the medullary groove. Cohn, however, doubts if mere mechanical pressure can cause such thinnings and actual holes. He has seen cases in normal, full term infants who had no spinal anomaly or any other evidence of increased intracranial pressure, but these are the cases of delayed development rather than resorption caused by pressure where there are spinal or cranial defects.

Baumm[1] cautions us that these anomalies should not be considered on a basis of osteogenesis imperfecta without the finding of other changes, especially congenital fractures.

In one of Vogt's[13] cases, even though the head was smaller than normal, there was a marked degree of relief skull, but no definite evidence of increased intracranial pressure. Encephalography after excision of the occipital meningocele showed greatly dilated ventricles with development at this time of considerably increased pressure.

The cases of delayed ossification usually go on to complete healing within three to four months, with normal hardening of the sutures. Those with delayed closure of the parietal fissure or foramen may show either complete ossification or there may be left the "third fontanelle" or a persistent parietal foramen.

In the cases of true relief skull, none has been found without an accompanying meningocele or encephalocele with or without club feet or other signs of disturbance of the lower cord. These cases, almost without exception, have gone on to an early death either from hydrocephalus following surgical attack on the tumor mass, as in Case 1, or from infection of the meningocele. It would be extremely interesting to follow one of these cases which had been operated on by the method recently advocated by Penfield and Cone[8] in which the sac is folded in and not removed so that its absorbing value is not disturbed. It may be found, however, that they are of the type that goes on to hydrocephalus in spite of such treatment.

CASE REPORTS

Case I. M. J. K. Patient fifteen days old was brought to the University Hospital, April 10, 1930, because of "lump" over the lower back. This had been present since birth and had gradually increased in size. Examination revealed an ulcerated, raised lesion over third and fourth lumbar vertebrae, evidently a meningocele. Fontanelles seemed tenser than normal. Skull measurements were as follows: occipito-frontal 35 cm., suboccipito-bregmatic 33 cm., and occipito-mental 39 cm. No roentgen examination made at this time. No surgery was advised.

Patient was brought back August 9, 1930, when about four and a half months old, showing beginning hydrocephalus but appearing otherwise well. The skull showed just a suggestion of "steeple skull." The posterior fontanelle was closed; the anterior appeared of normal size and showed no increased tension. Examination showed some increase in size of meningocele. Roentgen examination showed spina bifida with meningocele and changes in the skull characteristic of "relief skull" or "Lückenschädel." The fontanelles were not bulging and the sutures were still open but not widened—rather narrow, in fact (Fig. 2). Operation August 19, 1930, with removal of sac. Following operation patient became rapidly worse with signs and symptoms of increased intracranial pressure and died August 24, 1930.

Case II. B. J. B. Born November 4, 1931. Breech presentation. Birth weight 3,360 gm., length 51 cm. Diameters of head: Occipito-mental 12.5 cm.; occipito-frontal 11.5 cm.; suboccipito-bregma 9.5 cm. Circumference suboccipito-bregma 34 cm. Lumbosacral meningocele at birth with partial paresis of legs. Two days after birth, a tumor mass the size of a walnut appeared in suboccipital region. This was tense and cystic. Lumbar meningocele began to leak soon, and on December 1, 1931, it ruptured and drained. On December 16, 1931, there were definite convulsions and facial twitchings, which were interpreted as signs of meningitis. The skull showed increasing hydrocephalus.

Roentgen examination two days after birth showed the suboccipital and lumbosacral meningoceles with spina bifida and the changes in the skull which are characteristic of "relief skull" or "Lückenschädel"; the sutures were of normal width and the fontanelles were not bulg-

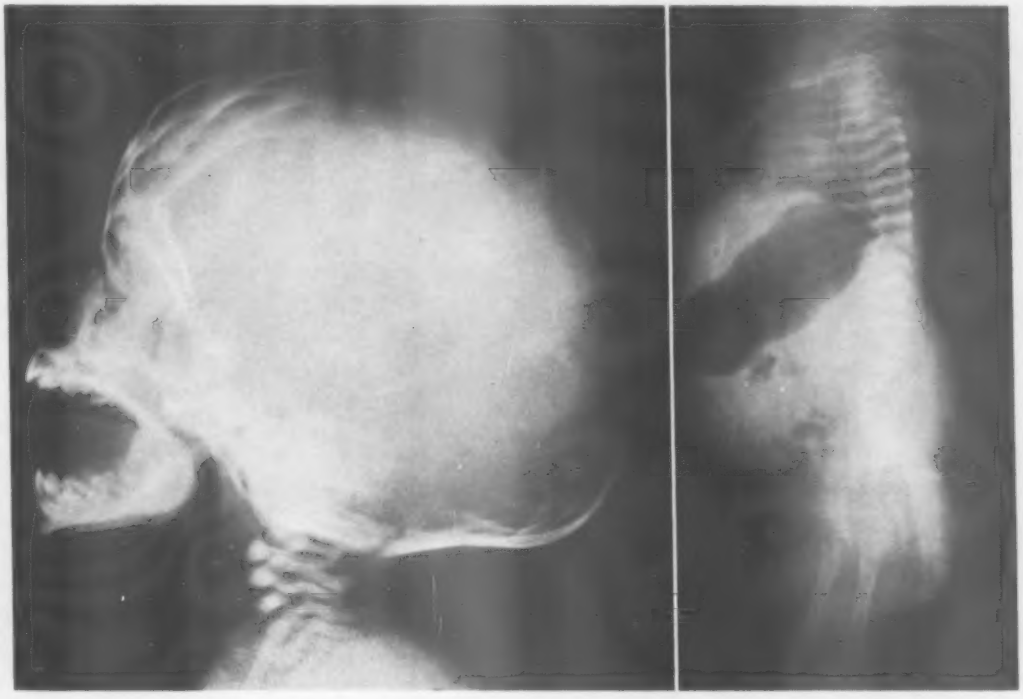

Fig. 3. Case II. "Relief skull"; normal diameters, sutures and fontanelles; spina bifida with meningocele.

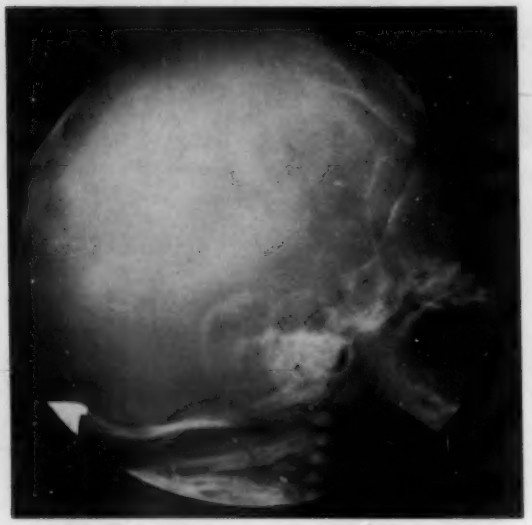

Fig. 4. Case II. After infection, showing hydrocephalus with bulging fontanelle.

ing (Fig. 3). Following the infection, skull began to enlarge rapidly and now shows the changes typical of hydrocephalus (Fig. 4).

Case III. D. J. Male child seven weeks old, brought to the University Hospital December 24, 1931, because of swelling over lower back. Birth was a normal breech presentation without instrumentation. Child appeared normal except for a red spot over the lower back, but a tumor began to form in this region soon after birth. Examination showed a mass over the lumbar region about 3 in. in diameter at its base, and 1 in. elevation. It was reddened over the top and showed crusting suggestive of dried cerebrospinal fluid. Severe bilateral clubbed feet. Roentgen examination showed lumbar spina bifida and meningocele with skull changes characteristic of "relief skull" or "Lückenschädel." There was, however, not only no widening of the sutures but they appeared definitely narrower than usual, suggesting premature closure (Fig. 5).

COMMENT

That the typical relief skull (Lückenschädel) shows a roentgenologic picture simulating the digital impressions seen in older individuals with increased pressure cannot be doubted. There remains, however, the normal width of sutures, at times small skull (Heubner, Vogt), and flat fon-

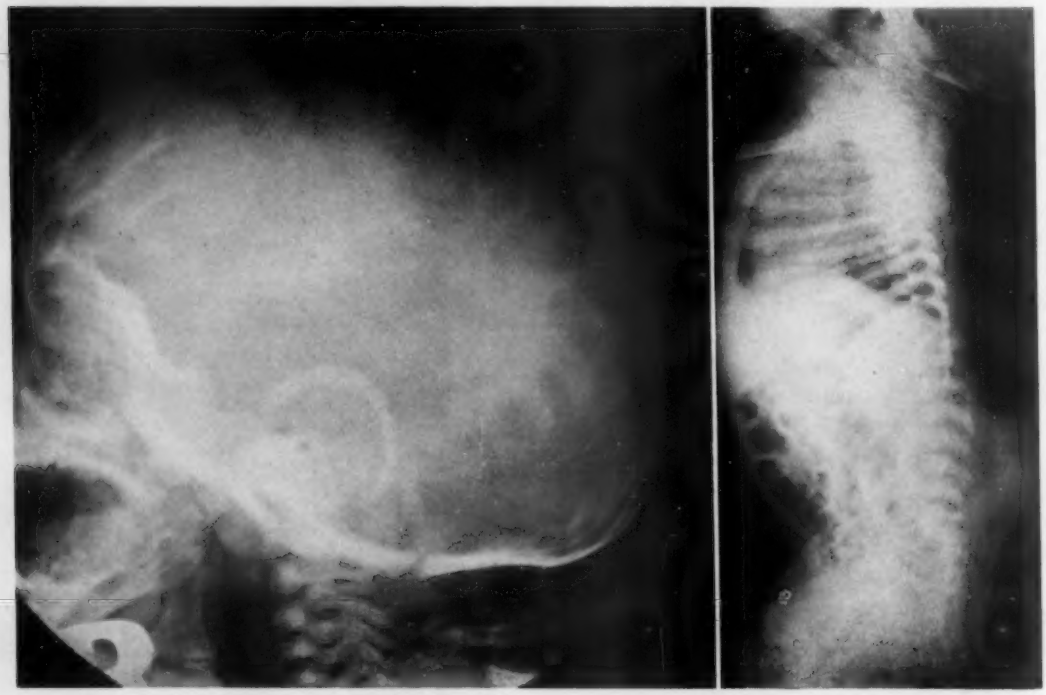

Fig. 5. Case III. "Relief skull" with spina bifida and meningocele. Sutures open but narrow rather than wide.

tanelles to be explained. It must be remembered that while the pressure atrophy on the inner table of the skull is being produced, the entire fetus is enclosed in the amniotic fluid. Selective enlargement of the head, as at the fontanelles is, therefore, almost impossible, and the pressure manifests itself not by general enlargement of the skull, but either by absorption of the overlying bone (or lack of its normal development due to pressure) or by an atrophy of the brain substance through flattening of the convolutions or enlargement of the ventricles, or by the action of both factors. Some molding of the cranial bones is seen in about 50 per cent of the skulls of the new-born, and is probably due to too rapid growth of the brain in the last one or two months of fetal life (Wieland). Wieland and Faust have already spoken of the meningoceles as "safety valves" and this has recently been emphasized by Penfield and Cone. This seems the most plausible explanation for the absence of widened sutures and bulging fontanelles, since after birth the sac seems to be more distensible than the suture lines or fontanelles. With the removal of the meningocele, any case of spina bifida will probably go on to hydrocephalus as has been noted by numerous authors. That this can also follow infection, either spontaneous or after surgical attack, was first shown by West[15] in 1875. Following the second paracentesis of a cervical meningocele in his case, infection set in and the patient rapidly developed hydrocephalus. Death ensued within a short time. At autopsy, the meningeal sac was completely sealed off from the remainder of the cerebrospinal fluid pathways. In relief skull, however, the pressure has already manifested itself in utero in the cranial and cerebral atrophy. The findings in our second case can readily be explained on this basis. Vogt's case seems to be of the same type. In our other two cases, the roentgen findings in the skull suggest that premature closure of the sutures may also be a factor of considerable importance in exaggerating the skull findings after birth (Fig. 2). Engstler's observation that the normally thick, arched parts of the skull corresponded with the cerebral vessels is what one would expect to find if the changes were due to increased pressure, since the vessels lie in the sulci, between the convolutions.

CONCLUSIONS

1. Three cases of relief or lacuna skull (Lückenschädel) are reported.

2. Its occurrence with meningocele and spina bifida is again emphasized.

3. Its etiology is explained on a basis of intrauterine increased intracranial pressure.

4. This increased pressure may not be manifest after birth because of the safety valve action of the meningeal sac, the cranial and cerebral changes having already occurred, however.

5. The additional factor of premature closure of the cranial sutures is also brought out.

REFERENCES

1. Baumm, H. Der Weich- und Lückenschädel des Neugeborenen. *Med. Welt.*, 1930, *4*, 1239.
2. Cohn, M. Zur Lehre vom Weich- und Lückenschädel der Neugeborenen. *Jahrb. d. Kinderh.*, 1924, *56*, 333–350.
3. Engstler, G. Ueber den Lückenschädel Neugeborener und seine Beziehung zur Spina bifida. *Arch. f. Kinderh.*, 1904–05, *40*, 322–329.
4. Faust, H. Ueber den angeborenen Relief- und Lückenschädel und seine genetischen Beziehungen zu Spaltbildung im Medullarrohr. *Beitr. z. path. Anat. u. z. allg. Path.*, 1931, *86*, 613–632.
5. Heubner. Quoted by Engstler, ref. 3.
6. Kassowitz. Quoted by Cohn, ref. 2, and by Wieland, ref. 14.
7. Kato, Y. Ueber angeborenen Relief- und Leistenschädel bei Spina bifida und Enzephalozele. *Virchow's Arch. f. path. Anat.*, 1913, *211*, 438–455.
8. Penfield, W., and Cone, W. V. Spina bifida and cranium bifidum. *J. Am. M. Ass.*, 1932, *98*, 454–461.
9. von Recklinghausen, F. Untersuchungen über Spina bifida. *Virchow's Arch. f. path. Anat.*, 1886, *105*, 243.
10. Schaeffer. Quoted by Cohn, ref. 2.
11. Schmidt, M. B. Quoted by Faust, ref. 4.
12. Thoma. Quoted by Cohn, ref. 2.
13. Vogt, E. C. Personal communication.
14. Wieland, E. Der angeborene Weich- oder Lückenschädel. *Virchow's Arch. f. path. Anat.*, 1909, *197*, 167–192.
15. West, J. F. Case of meningocele associated with cervical spina bifida. *Lancet*, 1875, *2*, 552.

IMPORTANCE OF THE ROENTGEN EXAMINATION IN POLYPOID TUMORS OF THE LARYNX

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IN A previous communication[2] the roentgen findings in a single case of polyp of the larynx were reported. To date 4 other polypoid tumors of the larynx have been seen at the Cincinnati General Hospital. All were easily outlined on the roentgenogram, and in 2 cases information was obtained from the roentgen examination which could be acquired in no other form of procedure. All of these tumors arose from the anterior wall of the larynx either just above or just below the anterior commissure. Four were benign, one malignant. The ages of the patients ranged from five to sixty years.

Benign tumors of the larynx are probably more common than is ordinarily suspected. In Hay's series of 200 cases upon which he based his monograph,[1] there were 26 benign tumors of the pharynx and larynx. Nine of this number were demonstrated by the roentgen ray. According to Hay, the site of predilection is the vocal cords (16 cases). Other sites of involvement were as follows: epiglottis, epiglottic valleculus, anterior commissure, arytenoids, post-pharyngeal wall, aryepiglottic folds, and anterior wall of the laryngeal vestibule.

Polypoid tumors of the larynx can be demonstrated on the roentgenogram when they are so located as to be seen in profile. They are characterized by localized bulgings encroaching on the lumen of the larynx. Roentgenoscopic study gives information as to localized swellings of the soft parts and condition of the laryngeal ventricle. The technique of roentgenography is simple. The patient is placed with his shoulder against the plate changer, head erect and with an assistant steadying the head. The exposure, generally speaking, is that amount of energy required for an anteroposterior examination of the chest of the patient in question.

Such study of the neck is very valuable in children and uncooperative adults. Two of our cases were quite young—five and six years respectively. Both of the children presented difficulties even in indirect study of the larynx. In fact, in one of the children no visualization of the larynx was done before the patient was taken to the operating room. However, the roentgenogram had confirmed the suspicion of tumor and had given accurate information as to the location and nature of the lesion. A third case was an elderly man who was not at all cooperative. This patient was brought into the Receiving Ward unconscious. It was necessary to do a tracheotomy. Subsequent roentgen examination gave essential information as to the nature of the obstruction.

CASE REPORTS

Case I. R. P. (No. R-10208), colored male, aged fifteen; chief complaint hoarseness of seven years' duration. This hoarseness had grown progressively worse until the patient could only whisper. There had been no respiratory difficulty. Past history was irrelevant. Physical examination was not unusual with the exception of laryngeal findings which showed numerous small papillomata springing from the anterior wall of the larynx and hanging between the vocal folds and holding them apart.

Roentgen examination—lateral view of the neck (Fig. 1). There is an ovoid mass approximately 1.5 cm. in diameter arising from the anterior wall of the larynx at the level of the fifth cervical vertebra. The laryngeal ventricle is not shown. It is interesting to note that the fact that the mass was made up of numerous small polypi could not be ascertained on the roentgenogram.

Case II. B. S. (No. 4787), white male, aged six; chief complaint hoarseness and respiratory

difficulty. This child had no symptoms referable to the larynx until four months before admission when he began to lose his voice. Several days prior to admission there had been considerable difficulty in breathing. The general physical examination was negative with the exception of mild respiratory difficulty. Due to lack of cooperation it was impossible to do even an indirect visualization of the larynx.

Roentgen examination—lateral view of the neck (Fig. 2). There is a globular mass arising from the anterior wall of the larynx at the level of the fourth cervical vertebra. The edges of this mass are indistinct and fade off into the surrounding background. Due to this indistinctness in outline it was thought that the tumor must be multiple in character. The laryngeal ventricle was not visualized.

At operation, under direct laryngoscopic vision, multiple small polypi were seen arising from the anterior wall of the larynx just below the cords.

Case III. R. M. (No. 2968), white male, aged five; entered the hospital complaining of loss of voice. Hoarseness was the initial symptom. On admission the child could barely whisper. There had been occasional choking on swallowing.

Roentgen examination—lateral view of the

Fig. 2. Case II. There is an indefinite tumor mass on the anterior wall of the larynx at the level of the laryngeal ventricle.

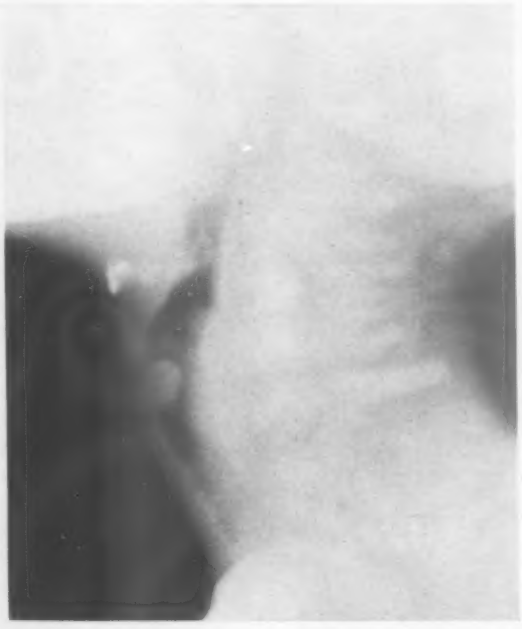

Fig. 1. Case I. The tumor mass is outlined arising from the anterior wall of the larynx.

Fig. 3. Case III. Note the localized bulging on the anterior wall.

Fig. 4. Case iv. The tumor mass is located just below the anterior commissure. The anterior portion of the laryngeal ventricle is visualized.

neck (Fig. 3). There is a tumor mass approximately 0.5 cm. in diameter arising from the anterior wall of the larynx at the level of the laryngeal ventricle.

Direct laryngoscopic examination disclosed a small growth about the size of a pea situated in the anterior commissure hanging between the vocal cords.

Case iv. M. D. (No. 5564), white female, aged nineteen; chief complaint hoarseness; onset of present illness two years prior to admission. There had been slight respiratory difficulty with choking spells at night and an irritating cough. Past history was irrelevant. General physical examination was negative.

Indirect laryngoscopic examination showed the epiglottis to be normal. There was a small wart-like growth about the size of a small grape arising just below the anterior commissure.

Roentgen examination—lateral view of the neck (Fig. 4). There is a pedunculated tumor measuring 1×0.25 cm. on the anterior wall of the larynx at the level of the fourth cervical body. The anterior portion of the laryngeal ventricle is visible above the attachment of the mass.

Case v. H. G. (No. R-3465), white male, aged sixty. This patient was brought into the Receiving Ward unconscious. His respirations were labored and he was quite cyanotic. Onset of present illness one year before admission, hoarseness with increased respiratory difficulty. Before admission he began to choke, became cyanotic and lapsed into unconsciousness. Physical examination showed a markedly dehydrated white male of about sixty years, very cyanotic, with marked respiratory distress.

Indirect examination of the larynx showed a large tumor mass nearly completely obstructing the larynx. Tracheotomy relieved the respiratory difficulty. Subsequent roentgen examination showed a large pedunculated tumor mass arising from the anterior wall of the larynx and entirely obstructing the lumen (Fig. 5). Biopsy revealed squamous cell carcinoma.

Two stage laryngectomy was done. Examination of the specimen confirmed the roentgen findings. The mass was attached by a pedicle to the anterior wall. Had this fact been considered

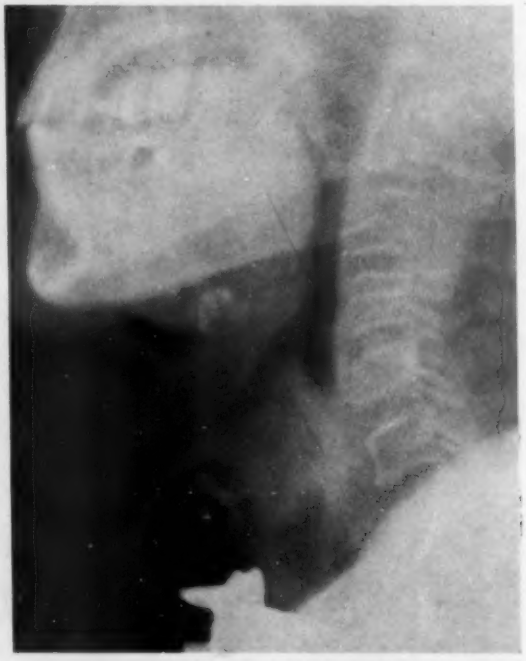

Fig. 5. Case v. The large tumor mass completely obstructs the larynx and is attached by a pedicle to the anterior wall.

a less radical operation would have been performed.

CONCLUSIONS

Polypoid tumors of the larynx can often be visualized with the roentgen ray.

Such examination is especially valuable in children and uncooperative adults.

Roentgen study may give information as to the type of operative procedure to be undertaken.

REFERENCES

1. Hay, P. D., Jr. The Neck. (*Ann. Roentgenol.*, Vol. IX.) Paul B. Hoeber, New York, 1930.
2. McGehee, W. H. Epithelial polyp of larynx demonstrated by roentgen ray. *Radiology*, 1932, *19*, 60–61.
3. Pack, G. T., and Carver, L. F. Tumors of the larynx and thyroid; roentgenographic study. *Arch. Otolaryng.*, 1931, *13*, 658–675.
4. Pancoast, H. K. Roentgenology of upper respiratory tract, with especial reference to larynx and adjacent structures. *J. Am. M. Ass.*, 1930, *95*, 1318–1321.

MEDULLARY SARCOMA OF VERTEBRA (EWING TYPE TUMOR)

WITH CYSTIC LESION IN RIB

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THIS case is reported because of the curious clinical picture it presented and because of the simultaneous occurrence of two dissimilar tumors of bone in a child.

N. B., male, aged thirteen; occupation, caddy; admitted October 13, 1931, on the service of Dr. Samuel Kleinberg.

The family, previous medical and surgical histories were unimportant.

Present History. Onset one year ago with dull pain in lumbar spine which radiated down left thigh. This pain recurred at irregular intervals without producing any disability. The total period of discomfort lasted but two months. About six months ago, he suddenly experienced great difficulty in walking. His peculiar gait was commented upon by his relatives and friends and has persisted to date. About six weeks ago, on the advice of a physician, he went to bed for a period of about one week, at the end of which time a plaster jacket was applied for the correction of a deformity in the lumbar region. He presents himself wearing a plaster jacket. About one week or ten days ago, he first noted a burning sensation in the right foot, which later radiated to the right thigh. Three days ago he developed a paresis of both lower extremities unaccompanied by either rectal or vesical incontinency. There is no anesthesia of either extremity. A spinal puncture performed two days ago by a private physician was reported negative.

Orthopedic Status. The back is symmetrical. The spine is in the midline. The lumbar curve is somewhat flattened and there is a prominence in the region of the second lumbar vertebra, but no definite knuckle formation. A slight muscle spasm is present. All movements of the spine are restricted. Patient walks awkwardly and with a marked ataxia. There is evidently marked weakness of both lower extremities. He lifts the extended limbs on both sides with the greatest difficulty, but when the knees are flexed he does so more easily. There is no evidence of paralysis, but there is extreme paresis of the muscles. Knee jerks and Achilles tendon reflexes are present.

Laboratory Data. The routine urine examination was negative and Bence-Jones protein was not found. Hematology: Hb, 70 per cent; red blood cells, 3,400,000; white blood cells, 7,000; neutrophiles, 61 per cent; eosinophiles, 1 per cent; basophiles, 1 per cent; lymphocytes, 38 per cent; mononuclears, 1 per cent. Blood chemistry revealed Ca 11. 5, and P 5. Serology: Wassermann, alcohol antigen, 1+; cholesterin antigen 2+. Complement fixation, negative. Quantitative tuberculin test, negative.

Roentgen Examination on October 20, 1931, revealed the following: Examination of the spine reveals a destructive process involving the body of the 3rd lumbar segment, which extends backward into the posterior arches, as well as into the transverse processes of this vertebra, particularly on the right side. The lesion is osteoclastic, practically no reactive changes being demonstrated. The articular surfaces of this vertebra appear to be intact and the body proper reveals a slight expansion, anteriorly, so that the anteroposterior diameter of this segment is increased. The joint spaces between the 2nd and 3rd, as well as between the 3rd and 4th lumbar vertebrae, appear to be intact. There is a slight collapse of the segment involved. The lateral view of the lumbosacral region reveals irregular erosion or destruction of the posterior surface of the 1st sacral segment, associated with some bone production in the soft tissues overlying this part. Examination of the ribs reveals localized cystic destruction in the 9th rib, right side, beginning about 3 inches from its spinal attachment and extending outward in this rib for a distance of 1 1/2 inches. A moderate expansion of the rib is present. No reactive changes can be demonstrated. Examination of the skull, lungs, dorsal spine, shoulder girdles and pelvis is roentgenographically negative. Conclusion: Malignant tumor, 3rd lumbar vertebra with metastasis

to the 9th rib, right side and probable metastasis to the sacrum (Figs. 1 and 2).

It seemed obvious from the roentgenogram that we were dealing with a neoplasm involving the spine, rib, and possibly the sacrum. As it was impossible to identify the lesion roentgenographically, it was considered advisable to remove a section of the rib for microscopic study. Accordingly, a section was resected subperiosteally by Dr. Kreitman. The specimen was examined by Dr. Henry Jaffe who reported as follows:

Gross: Specimen consists of part of a rib measuring 6 cm. in length and about 1.5 cm. in width at its widest point. On making a sagittal section through the entire length of the rib it is found that the rib over a distance of about 1 cm. appears normal. The cortex is of normal thickness and compactness. From this point on the rib shows expansion with conversion of the marrow cavity into a more fibrous and spongy bone. On the ballooned-out area of the rib, multiple cystic spaces measuring as much as 1 cm. in diameter are seen. The cystic spaces are partitioned off by a thin wall of fine bony trabeculae. The cysts contain no fluid or inflammatory bone tissue. The cyst walls are bony and somewhat irregular, but small amounts of granulation tissue could be removed. *Microscopic:* The expanded portions of the ribs show cysts free of tissue. The walls are lined by thin fibrous tissue layer underneath which is newly formed fiber bone. The cysts are trabeculated and in the expanded portion of the rib the marrow adjacent to the cysts contains large collections of lymphocytes. No lymphoid follicles are seen. Within the collections of lymphocytes, some polymorphonuclear leucocytes are also observed. The cortex adjacent to and in the vicinity of the cysts shows some enlargement of the vessel canals and some evidences of transformation with an irregular architecture. *Diagnosis:* Simple multilocular cysts of the rib (Figs. 3 and 4).

Fig. 1. Destructive lesion in the body of the third lumbar vertebra involving the lateral arches. Note intact intervertebral joints and slight compression of the segment.

On the fourth day after operation, the patient developed a profuse watery diarrhea which persisted for three days. Blood examination at this time revealed a moderate leucocytosis. A diagnosis of acute enteritis was made and after proper medication, this acute situation rapidly subsided. On November 9, 1931, he was placed on a convex frame. Examination

one week later revealed a hard mass in the abdomen at the level of the spinal lesion. This mass was somewhat globular, about the size of a walnut and non-sensitive.

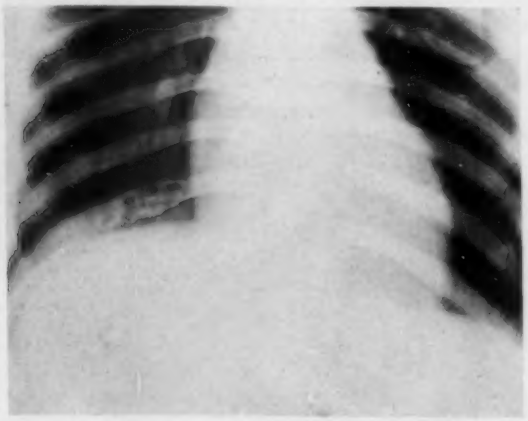

Fig. 2. Cystic trabeculated and expansile lesion in ninth rib right side.

The situation at this time (Nov. 23, 1931) was as follows: The tumor of the rib had been proved a benign cyst of bone and the assumption was that the lesion of the vertebra was of identical nature. The patient's general condition was good, the fever had subsided, but the paresis was progressing and the pain becoming more intense. There appeared to be every clinical indication for surgical interference and it was thought that further collapse of the vertebral column could be prevented by a decompression and fusion operation. At the same time, a specimen of the tumor could be removed to further establish the nature of the neoplasm. Accordingly, the patient was operated upon and Dr. Kreitman's notes are as follows: A 6 in. midline incision was made over the spinous processes of the 12th dorsal to the 5th lumbar vertebrae. The spinous processes and laminae on the left side were exposed subperiosteally. As the intervertebral joint between the 2nd and 3rd lumbar segments was exposed, it was found that there was granulation tissue between the two laminae. The laminae and spinous processes were then exposed; on the right side, this same granulation tissue was found in the same relationship as on the left side. The laminae of the 2nd and 3rd lumbar vertebrae were found to be mottled and appeared to be somewhat softer than those of the other vertebrae. The spinous processes of the 1st, 2nd, and 3rd lumbar vertebrae were removed and the laminae on the right side of these same vertebrae were opened. It was found that when the spinal column was first opened at the level of the 3rd lumbar vertebra the cord did not pulsate, but as the column was opened above, the cord began to pulsate. The extradural anterior portion of the canal was inspected and nothing of note was found. The dura was opened and a probe inserted above and below to make sure that there was no block farther above or below this point. The superior articular facet on the right side of the 4th lumbar vertebra was found to be soft and irregular. This was easily removed and with the finger it was explored laterally. As the finger was inserted laterally, there was a gush of a hemorrhagic, whitish, gelatinous fluid. With a curette, some of the bone in this area was removed. The bone chips that had been removed in performing the laminectomy on the right side were inserted over the laminae of the left side to bring about the spine fusion.

The specimens were referred to the laboratory for section and culture. The culture was reported sterile. The report of the section submitted to the laboratory was as follows:

Gross: Specimen consists of tissue removed from the spinous process and the laminae on the right side especially, and from a cystic structure that was opened into in one of the

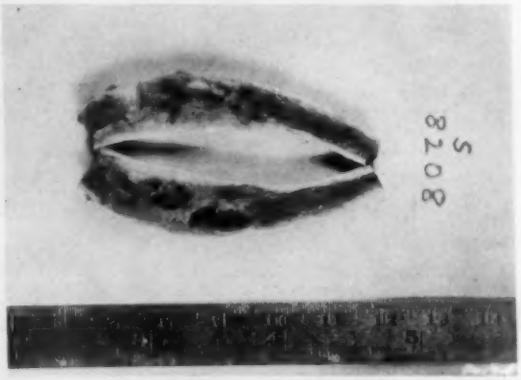

Fig. 3. Photograph of the gross specimen, natural size, showing part of the normal rib and also the expanded rib with cysts.

bodies of the lumbar vertebra after the cord was pushed to the left. The soft tissues from the cystic cavity showed on smears, an absence of bacteria, and in the Wright and Gram stains the cells were very large and contained nuclei

that apparently occupied the whole cell. Some of this soft tissue was almost of the consistency of pus and this was cultured. The rest was marked No. 1. The soft tissue and spongy bone removed from the cavity were marked No. 2, and decalcified in nitric acid. The tissue from the lumbar and spinous processes which in the gross showed nothing was marked No. 3 and was also decalcified in nitric acid. *Microscopic:* Sections from the tissue marked No. 1 show numerous small vessels that are thickened. Between these vascular spaces there are collections of deep-staining blue cells but also others in which the cells do not stain well. Sections from the tissue marked No. 2 show similar collections of dark-staining cells subchondrally with marked areas of resorption of the bone and intertrabecular scarring. Other sections show a very vascular and edematous marrow with marked resorption of the bony trabeculae. In this vascular, edematous marrow there are clumps of large blue-staining cells. The marrow shows some fibrous reaction with scarring. In the sections marked No. 3 some of the intertrabecular spaces contain masses of cells, the cell borders of which are not very distinct. These cells have large nuclei that fill practically the entire cell. They are fairly compact and they become continuous with the adjacent fibrotic marrow. Other sections show fairly

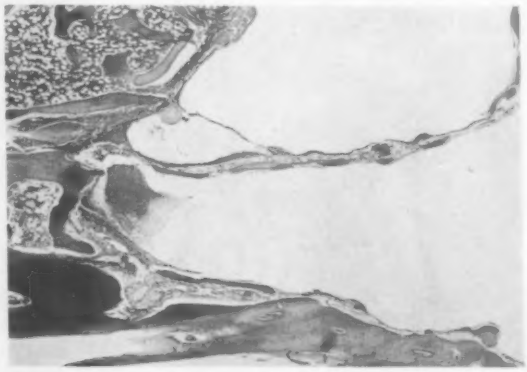

Fig. 4. Photomicrograph of part of this rib showing the cortex and two cysts partitioned by a thin septum which is made up of fine trabeculae of bone. The bone marrow except where it is immediately adjacent to the cyst appears normal in all respects (×15).

diffuse tumor, but in other areas scarring is observed with clumps of leucocytes, in fact in some places resembling miliary abscesses. *Diagnosis:* Medullary sarcoma (so-called Ewing's tumor) (Fig. 5).

Re-examination, both gross and microscopic,

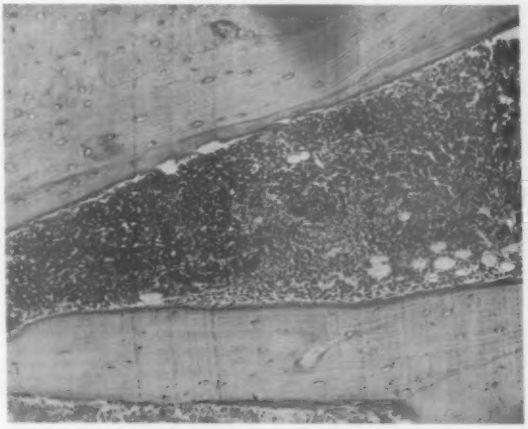

Fig. 5. Shows some of the tumor between two trabeculae of bone from spine. The tumor cells are quite compact, blue-staining. The entire mass is rather solid (×100).

of the rib specimen failed to reveal any evidence of a lesion suggestive of sarcoma. While speculation is possible no evidence exists for believing that the rib also had a sarcomatous focus which had undergone spontaneous resolution with the resultant cystic transformation which was observed on roentgen examination and is shown in Figure 3.

Following the operation, there was a moderate rise in temperature, without, however, any discomfort. Patient stated that the right lower extremity had somewhat improved. However, his appetite failed and his anemia became pronounced. A transfusion of 500 c.c. of blood was done on December 4, 1931. I quote from the clinical notes by Dr. Kleinberg. "On December 4, he had a transfusion of 500 c.c. of blood. Since that time, temperature has receded to normal; the pulse is now normal. He looks very much better and feels better. Patient states that numbness in the right lower limb is gradually disappearing. The knee jerks are not present. The ankle jerks are absent. There is no power in the right lower limb except for a little power in dorsiflexion of the foot and toes. He has also slight power in the sartorius and flexors of the knee. Left lower limb: He is able to flex it at the hip and knee. There is some power of extension in the quadriceps. There is very slight power of dorsiflexion of the foot. The wound of

the spinal operation is healing satisfactorily."

In view of the report from the pathological department, it was decided to treat the affected areas by means of a radium pack, and the treatment was administered in the following manner: On December 19, 1931, a 335 mg. pack was applied to the lumbar region posteriorly over the tumor. A total irradiation of 8,040 mg-hr. was administered over a field 8×10 cm. at a focal skin distance of 6 cm. and filtered through 2 mm. of lead. On December 20, the same pack was administered anteriorly at the level of the lesion using the same factors and giving a total radiation of 6,365 mg-hr. On December 31, the lumbar area posteriorly was irradiated using the same factors for a total of 8,040 mg-hr.

On December 31, 1931, the abdominal masses were no longer palpable and there was a marked reduction of pain. Mobility of the spine had increased and the function of the left leg improved. The right lower extremity was unaffected. Four days later, motion in the left lower extremity was freer and there was some return in the power in the right lower extremity. His improvement was fairly rapid and the patient was accordingly discharged on January 6, 1932, and advised to return for further observation and, if necessary, irradiation.

DISCUSSION

In the roentgen diagnosis, the following conditions were considered: tuberculous caries with concomitant involvement of a rib; vertebral osteochondritis; fibrocystic disease and malignant tumor with metastasis to the rib.

Tuberculous caries was excluded because there was no involvement of the intervertebral joints and insufficient collapse of the vertebral segment considering the extent of the destructive process. The destruction appeared to involve the body proper rather than its articular surfaces. There was no paravertebral soft tissue thickening. The involvement in the rib was expansile in character rather than destructive, as one would expect in tuberculosis.

Vertebral osteochondritis results in compression of the involved segment associated with condensation of the cancellous structure, so that the body appears denser than normal. In the case cited the vertebra showed patchy necrosis. Considering the extent of the destructive lesion in the involved segment, there was no very striking compression of the body. We would still have to explain the nature of the lesion in the rib.

Fibrocystic disease. The lesion in the rib was expansile in character, cystic in appearance and showed slightly eburnated edges. The diagnosis of cystic bone disease would have been justified but would not have explained the nature of the lesion in the vertebra. The lesion in the vertebra was "moth-eaten" in character, not expansile and showed no trabeculations.

While the two lesions were dissimilar roentgenologically, it appeared more logical to assume that they were both unusual manifestations of one disease. The diagnosis of a malignant tumor of the vertebra with metastasis to the rib was therefore made by exclusion.

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THE INCIDENCE OF MALIGNANCY IN CHRONIC PREPYLORIC GASTRIC ULCERATIONS*

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THE purpose of this communication is to emphasize a relatively new factor in the differential diagnosis of chronic prepyloric gastric ulcerations. This factor pertains to the anatomical location of the lesion. Observations are reported which seem to indicate that chronic prepyloric gastric ulcerations should be considered and treated as malignant ulcers. The facts obtained from a study of the records of the Massachusetts General Hospital over a period of ten years and the results of three years of practical application of these findings are presented. No attempt will be made to evaluate other well-recognized diagnostic criteria; indeed, these criteria are intentionally omitted.

The utilization of the site of a lesion as an aid in the diagnosis of disease is a well-recognized procedure and is used in many departments of medical diagnosis. It is well recognized in dermatology that certain diseases of the skin involve usually the flexor surfaces of the extremities while others involve most frequently the extensor surfaces. In pulmonary disease, it is a well-known and generally accepted dictum that all lesions above the third ribs in front are to be considered tuberculous until proved otherwise and that all lesions below the third ribs in front should be considered non-tuberculous until proved otherwise. The occasional occurrence of a non-tuberculous lesion above the third rib and the comparatively rare finding of a tuberculous lesion below the third rib in front does not invalidate but rather serves to strengthen the dictum.

An example of the utilization of the location of a lesion as an aid in the diagnosis of gastric disease was presented before this Society by Sproull[6] in his discussion of the occurrence of benign ulcers on the greater curvature of the stomach. His conclusions were that any lesion situated on the greater curvature of the stomach would be safely diagnosed as neoplastic on the basis of location without regard to or consideration of other diagnostic factors. We have found that this method, namely, localization, may be used to determine the nature of prepyloric ulcerations. It is well known that the benign or malignant nature of some gastric ulcerations cannot be determined by gross examination.

The exact location of benign chronic gastric ulcerations has not received sufficient attention if one is to judge from the statements made in the many medical textbooks and periodicals. Many authorities believe that these ulcers occur most commonly in the lower third of the stomach. The "gastric pathway" and "the ulcer-bearing area of the stomach" are unconvincingly discussed. However, a few pathologists and roentgenologists have studied this subject carefully and have attempted to localize the areas within the stomach in which benign ulcer or carcinoma are more likely to be found.

In 1925, Orator,[5] working with material obtained from the Eiselberg Clinic, attempted to correlate the sites of occurrence of chronic gastric ulcerations with their tendency to undergo malignant degeneration. He also discussed the relation of diffuse and localized chronic gastritis to the malignant degeneration of gastric ulcers. His work is of great value both for the completeness of his study and the accuracy of his observations. He is quoted by Haudek,[3] Camp,[1] and others. His material consisted of 330 stomach specimens showing ulcerations which were studied grossly as to location; and histological studies were also done to determine the presence of

* Read at the Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27–30, 1932.

malignant degeneration. A part of his work is tabulated by us in Table I.

It is not the purpose of this presentation to decide whether or not benign gastric ulcers become malignant. Particular attention is directed to the percentage of prepyloric ulcerations which Orator interprets as having undergone malignant changes. If we have translated his statements correctly, he has classed the group of 15 questionable ulcerations chiefly within the prepyloric area. He definitely states that the 11 prepyloric ulcerations which had apparently degenerated into malignancy would be increased in number if he had included the questionable group. It is apparent, therefore, that Orator found benign ulcers in the prepyloric area in 6 per cent or less of the total cases studied.

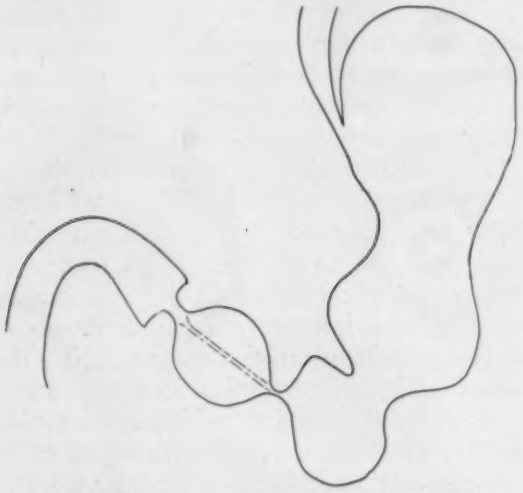

Fig. 1. The distal egg-shaped portion of this diagrammatic sketch of the stomach represents the prepyloric area as defined. The pyloric valve is not included in the prepyloric area. The dotted lines represent the lumen of the stomach as the peristaltic waves "canalize" it. The length of the lesser curvature side of the prepyloric area is taken to be one inch.

Table I

Gastric Ulcerations (Orator)

Media lesser curvature	300	
Prepyloric	30	
Malignant Degeneration		
		per cent
Media lesser curvature	6	2
Prepyloric	11	30
Questionable	15	30+

Haudek, reviewing his experience of many years in the roentgen diagnosis of gastric lesions, recognized the difficulties experienced in distinguishing between benign and malignant lesions in the prepyloric region. He states:

"The prepyloric segment is the most frequent site of carcinoma—about 80 per cent of carcinomata start here. Ulcers are certainly least commonly found here—occurring in about the proportion of 1 to 10 as compared with ulcers of the pars media. But the relatively small number of ulcers which occur in this region have three peculiarities which complicate the differential diagnosis: (1) They show 'niches' less frequently than in other situations. (2) These ulcers are associated with more marked submucous oedema, with an increased tendency to spasm of the gastric musculature, and a more considerable degree of mucous membrane swelling. As a result the lumen of the pyloric part of the stomach is quite often narrowed, giving appearances similar to carcinoma." A case is here quoted. He continues: "My own experience agrees with the facts established by Orator on material from the Eiselsberg Clinic that about one-third of prepyloric ulcers undergo cancerous degeneration, but only 3 per cent of ulcers of the pars media, and hardly ever a duodenal ulcer. *The difficult differential diagnosis*

Fig. 2. The shaded portions of this diagram illustrate the usual site of occurrence of chronic benign ulcers. Note that the prepyloric area, greater curvature, and cardiac end are left blank.

and the tendency to malignant degeneration are sound reasons for recommending operation in prepyloric ulcer." (The italics are ours.)

Lehmann[4] examined the stomach and duodenum in a series of 1000 necropsies for signs of active or healed ulcers. He based his findings on both the gross and histological evidence. Ulcers or the scars of ulcers were found in 202 cases; in the stomach the relation of scars to active ulcers was as 9 to 1, the number of active ulcers increasing as the pylorus was approached. By far the greater number of scars were located toward the cardiac end of the stomach. He did not state definitely the number of ulcers or scars in the prepyloric area; instead, he used such terms as "near the pylorus" and "away from the pylorus." It is interesting to note that one of his illustrative sketches contains markers indicating that only two healed ulcers were in the prepyloric area.

Camp, in a summary of the facts concerning prepyloric ulcer obtained from the literature and from the material at the Mayo Clinic, states that it is apparent that the roentgenologic simulants of the lesion are numerous and far more common than prepyloric ulcer itself. He advised withholding a diagnosis unless an ulcer niche can be demonstrated without question.

Stone and Ruggles[7] have noted the frequency with which prepyloric lesions are found to be malignant. They report one case of proved benign prepyloric ulcer.

Dresser[2] quotes Lehmann and refers to the frequency with which benign ulcer occurs on the lesser curvature of the stomach.

We deem it necessary at this point to define the term "chronic prepyloric ulcerations" as used in our study of the subject. It is desired that "chronic" be not ignored but interpreted literally and perhaps it would be better if "indurated" were added. The prepyloric area is here sharply limited to that portion of the stomach just proximal to the pyloric valve which is one inch in length. No part of the pyloric valve is included in the prepyloric area. Aside from actual measurement, this portion of the stomach may be identified during roentgenoscopy by its canalization at the height of peristaltic activity. In some of the lower animals this portion of the stomach is grossly demarcated; for example, an abrupt change in both the gross and histological

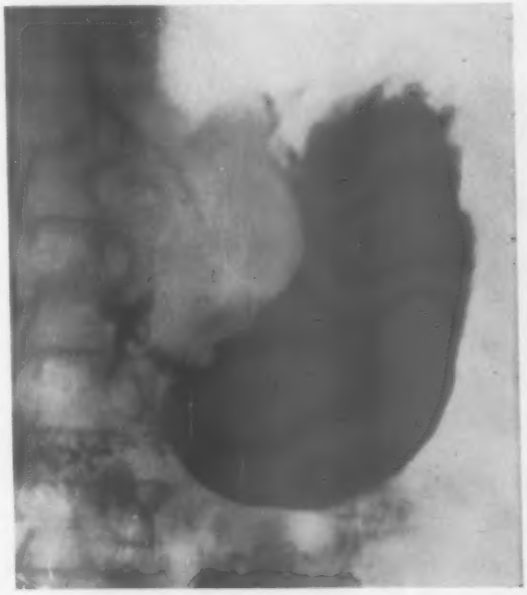

Fig. 3. The roentgen diagnosis was duodenal and gastric ulcer. The position of the gastric ulcer niche was recorded by the roentgenologist as being "at the upper margin of the deformed prepyloric area," but the pathologist placed the lesion within one inch of the pyloric valve.

structure is noted in the rat's stomach just above the pylorus. Often, in the freshly removed human stomach, a definite transition is noted in the mucosa at the beginning of this prepyloric area. In view of the fact that it is seldom possible to study the mucosa of the stomach as it exists in the living, one may perhaps justly doubt the existence of accurate knowledge of the mucosa of the living human stomach. Certainly, the prepyloric area presents definite differences in physiological activity and response to disease when compared with the remainder of the stomach, and it is this inherent peculiarity which limits nearly

all diagnostic procedures directed to it (Figs. 1 and 2).

To determine as nearly as possible the exact locations of chronic gastric ulcers, it was considered best to select those records which contained roentgen, surgical, and pathological reports. Even though a period of ten years was covered, only a relatively small number of complete records were obtained due to the fact that most gastric ulcers are treated medically at the Massachusetts General Hospital. To locate the ulcers accurately, the center of each ulcer was taken as its site of origin; for example, an ulcer 6 cm. in diameter occupying the prepyloric area was localized at a point 3 cm. above the pyloric valve and was not classified as a prepyloric ulcer. All ulcers extending well into the pyloric valve were considered to be pyloric valve or duodenal ulcers since the anatomical landmarks were usually obscured. There is no doubt that some of the ulcers reported in the pyloric valve originated in the duodenum or elsewhere in the stomach and these we consider to be the greatest sources of error.

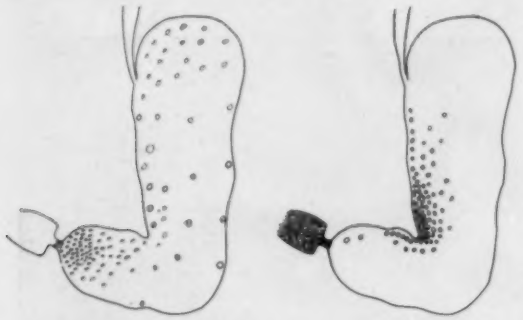

Fig. 4. In the diagram marked "ulcer," the site of the 128 proved benign gastric ulcers is indicated. In the opposite diagram, marked "cancer," the position of 121 carcinomata as localized and diagnosed by the roentgen examination alone is illustrated. Particular attention should be paid to the fact that most of the benign ulcers were placed in the middle third along the lesser curvature and posterior wall, whereas most of the carcinomata were found in the distal end of the stomach. The proportion of carcinomata as diagnosed by roentgen examination alone to proved prepyloric ulcers is considerably above the 12 to 1 ratio already stated.

With the above governing factors and the roentgen, surgical, and pathological reports taken into account, the following tabulation was prepared (Table II):

Table II
Location of Ulcer of Stomach (Roentgen, Surgical and Pathologic)

	Number	Per Cent
Location (?)	9	7.0
Pylorus	28	21.9
Near pylorus	6	4.7
Prepyloric	2	1.6
Media	83	64.8
Total	128	100

Nine of the ulcers could not be definitely localized due to destruction of the anatomical landmarks. The pyloric valve was thought to be the seat of ulcer in 28 instances. The most definite statement made in the record either by the surgeon, roentgenologist, or pathologist, was "near the pylorus" in 6 cases. In many records the term "near the pylorus" proved to be entirely misleading, for ulcers so localized by one examiner proved to be variously located from the middle third of the stomach to the duodenum by the other two examiners. It is surprising that only 2, or 1.6 per cent, of the ulcers were found to be definitely

Fig. 5. Pathological report—ulceration 1.5 cm. in diameter which on histological examination showed adenocarcinoma with metastases to regional lymph nodes.

within the prepyloric area. As the above tabulation was prepared before any of the literature was reviewed, it is interesting to compare our findings with those of Orator. If we add the "near pylorus" and "prepyloric" percentages in our table, the sum (6.3 per cent) corresponds closely with the percentage of benign prepyloric ulcers found by Orator (6 per cent). It is probable that he included more than the distal one inch of the stomach in the prepyloric area. Our records show that neither of the two prepyloric ulcers tabulated above could be so localized by the roentgen examination alone. Indeed, the roentgen diagnosis of chronic benign prepyloric gastric ulcer as defined by us was not confirmed by pathological examination in a single instance (Fig. 3).

It was thought advisable to establish the relative proportion of carcinoma and ulcer occurring in various portions of the stomach, and to do this it was found necessary to rely on the roentgen diagnosis alone since not enough complete gastrectomies were performed. The tabulation below is composed of material obtained from the Roentgen Department in the years 1928 and 1929. Several of the patients diagnosed as having ulcers were re-entries but nearly all of the patients thought to have carcinomata were examined only once (Table III).

Fig. 6. Pathological report—superficial ulcer 2 cm. from pylorus, 1 cm. in diameter, also small shallow ulcer 1.5×1.2 cm. in pyloric ring. Both ulcers show histological appearance indicating slowly growing scirrhous carcinoma.

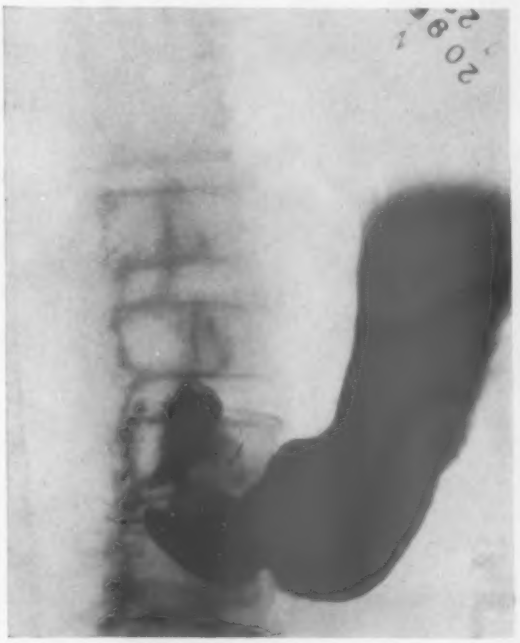

Fig. 7. Pathological report—3 cm. ulcer in contact with the pyloric valve which on histological examination showed adenocarcinoma.

The importance of comparing the location of benign and malignant lesions of the stomach is apparent. In practically an equal number of roentgen examinations of

Table III

Location of Ulcer and Carcinoma; Roentgen Diagnosis (1928 and 1929)*

	Ulcer	Carcinoma
Pyloric end (pylorus)	39	75
(prepyloric)	6	
Media	80	17
Cardia	3(?)	21
Diffuse	0	8
Total	128	121

* Relative proportion of prepyloric ulcer to carcinoma approximately 1 to 12.

the stomach, it was thought that there were 6 ulcers and 75 carcinomata involving the prepyloric area. Thus the relative proportion of benign prepyloric ulcers to carcinomata in this same area of the stomach is as 1 to 12, i.e., in a given case where definite pathology is localized to the prepyloric area the chances of the lesion being carcinoma are twelve times as great as are the probabilities of its being a benign ulcer. Of course, when one considers the sources of error in the roentgen diagnosis of prepyloric ulcer, the 12 to 1 ratio becomes much greater (Fig. 4).

In view of the above findings, it was thought advisable to follow up those patients who had had only posterior gastroenterostomies without any other operative procedure for the treatment of what was thought to be benign chronic prepyloric ulcerations. It was possible to obtain fairly complete records of 8 such patients. All of these patients returned to the hospital within an average period of two years, presenting unmistakable evidence of advanced carcinoma of the stomach (Table IV).

During the last three years, it has been possible to test the accuracy of the statistical data and theoretical considerations above presented. Although we had the cooperation of the surgeons, pathologists, and roentgenologists of the Massachusetts General Hospital, not a single instance of chronic benign prepyloric ulcer, as we have

Table IV

THE ROENTGEN, OPERATIVE AND FOLLOW-UP DIAGNOSIS IN EIGHT SELECTED CASES OF PREPYLORIC ULCER

Hospital Number	Roentgen Findings	Operative Findings	Final Diagnosis
283365	Gastric ulcer at the prepylorus (?); malignancy	Gastric ulcer on the lesser curvature 3 cm. above the pylorus (1927)	Tumor involving the pyloric end (1929), adenocarcinoma, removed; operative and pathologic diagnosis
273408	Obstruction at the outlet; probably malignant	Ulcer on the gastric side of pylorus (1925)	Operative findings, 1929: carcinoma, inoperable
272829	Obstruction at the outlet of the stomach	Thickening exactly at pylorus with ulcer above it (1925)	Roentgen and clinical findings, obvious carcinoma; patient died in January, 1927
262864	Obstruction at the pylorus	Lesion on the lesser curvature which ended abruptly at the pylorus; old callus ulcer (1924)	No operation; definite carcinoma; roentgen and clinical findings
481562	Obstruction at the pylorus, probably ulcer	Indurated lesion near the pylorus (1922)	Carcinoma lower third, 1923; adenocarcinoma; operative and pathologic findings
461562	Ulcer near the pylorus	Benign ulcer (1926)	Mass head of pancreas and large ulcer just above pylorus; malignant condition seemed certain (1927); operation
253091	Obstruction at the pylorus, probably ulcer	Ulcer above the pylorus (1921)	Enlarged liver, jaundice; roentgen diagnosis: carcinoma of the stomach (1922)
250411	None	Gastric ulcer (1920)	Palpable mass, obvious carcinoma (1922)

defined it, has been discovered.* In contrast with this, 13 malignant prepyloric ulcerations were resected which were 3 cm. or less in diameter. A large percentage of these ulcerations were thought to be benign by the surgeons and pathologists from a study of their gross pathology. Examination by routine frozen sections was not found dependable for accurate diagnosis nor was it possible to arrive at a correct histologic diagnosis by the study of a single paraffin section. It was found necessary and it has become our custom to require several paraffin sections from various portions of these prepyloric ulcerations before the histological diagnosis is accepted (Figs. 5, 6, 7 and 8).

* Since this paper was read, 2 benign prepyloric ulcers and 5 prepyloric malignant ulcerations (3 cm. and less in diameter) have been discovered. One of the patients presenting a benign prepyloric ulcer had a positive Wassermann and the ulcer was on or very near the greater curvature.

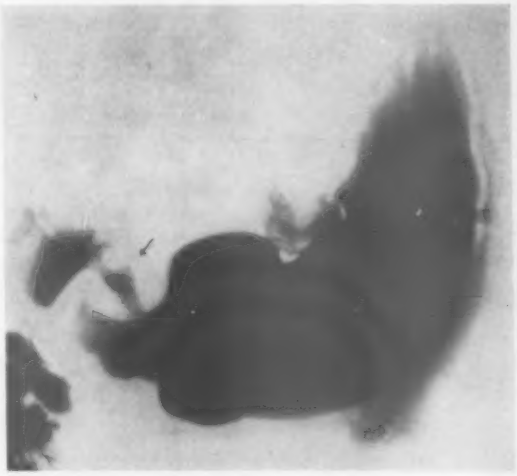

FIG. 8. Pathological report—ulcerating lesion 2.3 cm. in diameter extending into pylorus. Lesion is slightly firm and margins raised about 4 mm. Microscopic diagnosis—adenocarcinoma with metastases to regional lymph nodes.

REFERENCES

1. CAMP, J. D. The roentgenologic significance of pyloric and prepyloric deformities. *Radiology*, 1931, *16*, 847–855.
2. DRESSER, R. The roentgen examination for peptic ulcer, with special reference to those cases presenting unusual difficulties in diagnosis. *N. England J. M.*, 1931, *205*, 395–399.
3. HAUDEK, M. X-Rays in diagnosis of early carcinoma of the stomach. *Brit. J. Radiol.*, 1929, *2*, 421–433.
4. LEHMANN, H. Ein Beitrag zur Frage der Frequenz und Lokalisation des Ulcus pepticum, ventriculi et duodeni. *Mitt. a. d. Grenzgeb. d. Med. u. Chir.*, 1926, *39*, 185–204.
5. ORATOR, V. Beiträge zur Magenpathologie. II. Zur Pathologie und Genese des Carcinoms und Ulcuscarcinoms des Magens. *Virchow's Arch. f. path. Anat.*, 1925, *256*, 202–229.
6. SPROULL, J. A discussion of the occurrence of benign ulcer on the greater curvature. AM. J. ROENTGENOL. & RAD. THERAPY, 1931, *25*, 464–473.
7. STONE, R. S., and RUGGLES, H. E. The diagnostic value of prepyloric and pyloric roentgen findings. AM. J. ROENTGENOL. & RAD. THERAPY, 1932, *27*, 193–204.

FURTHER ROENTGEN-RAY STUDIES ON CARCINOMA OF THE STOMACH*

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IN A previous communication presented before the Radiological Society of North America in 1929,[1] I demonstrated the possibility of recognizing early gastric lesions by means of the roentgen ray and called attention to the importance of the indirect or secondary roentgen signs obtained in gastric disease. When gastric lesions are visualized, especially the ulcerative or carcinomatous types, the roentgen examination usually reveals a characteristic filling defect. On the other hand, when a filling defect cannot be demonstrated the diagnosis becomes more difficult and uncertain. This is especially true in that type of case representing the early stages of the disease in which there is but slight induration in the gastric wall. It is impossible at this stage to visualize the ulcer crater or the small early neoplasm. Inasmuch as nearly all early lesions of the stomach present only an infiltration or induration, any sign that will point to these changes before the filling defect has become fully developed is most important. An attempt will be made to demonstrate that this can be accomplished in many instances. The importance of the indirect or secondary roentgen signs in the diagnosis has hardly been sufficiently emphasized and moreover too little attention has been directed to these findings as a possible means of establishing an early diagnosis at that period, before a filling defect can be detected. It is to these signs that we desire to direct attention. The gastric lesions in which the characteristic filling defects are noted are therefore not considered in this discussion.

Reference to the literature on this subject reveals but few communications regarding the early roentgen signs of organic disease of the stomach. While mention is unquestionably called to the indirect signs, but slight significance has been attached to these findings. Positive indirect roentgen signs very frequently occur in many instances before the gastric defect is observed. These secondary signs, when constant, must be considered abnormal and strongly suggest the presence of a gastric lesion. They are repeatedly overlooked by the roentgenologist and their significance is often not fully recognized until later, when subsequent investigation discloses a definite lesion. It is then not unusual to observe that when the films are again compared, the site of the lesion on the films in the earlier examination is readily detected. The importance of frequent roentgen examinations in all instances in which clinical evidence of gastric disease is revealed must be repeatedly emphasized, especially when positive roentgen signs are absent.

My attention has been directed to this study by the observation of a group of cases presenting definite clinical and laboratory findings indicative of gastric disease, without, however, presenting a characteristic filling defect in the roentgen examination. In reviewing a large series of such cases I was especially impressed with the fact that a marked discrepancy existed between the clinical and roentgen findings. From a personal experience with the roentgenological changes observed in this group of cases, I am convinced that it is quite possible in many instances to distinguish these early indirect findings which have heretofore often passed unnoticed. The early recognition of these changes is

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[1] Feldman, M. Early recognition of gastric ulcer and carcinoma as revealed by roentgen-ray studies. *Radiology*, 1930, *15*, 449-459.

highly important in view of the fact that they may present the first intimation as to the true nature of the disease.

The material selected for this study comprises a group of 9 cases of carcinoma of the stomach, which are presented to point out the importance which must be attached to the indirect roentgen signs in the diagnosis of this condition. It is therefore the purpose of this communication to discuss briefly this group of cases which presented roentgen changes other than the characteristic projecting or displacing defects commonly observed in carcinoma. The diagnosis of carcinoma of the stomach was definitely established in each instance.

The roentgenological appearance of the configuration of the stomach presents a picture which varies greatly, depending upon the extent of the lesion. These changes may at times be so slight that it is difficult to detect a departure from the normal. On the other hand, the entire stomach may be involved producing roentgen changes which disclose the presence of an extensive lesion. In this study it was determined, in order to accurately appraise the value of the roentgen signs and properly classify each case, to divide them into two groups. First, the ulcer group and, secondly, the carcinomatous group. Some of our cases could not be classified into

Table 1. Case 1. Table illustrating the detailed blood examinations. (From the records of the Johns Hopkins Hospital.)

Date	Red Blood Corpuscles	Hemoglobin	White Blood Corpuscles	Differential count								Color Index	Remarks
				Polymorphonuclear Neutrophiles	Polymorphonuclear Eosinophiles	Polymorphonuclear Basophiles	Small Lymphocytes	Large Lymphocytes	Monocytes	Unclassified	Myeloblasts		
		per cent		per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	
Nov. before entering Hospital	2,500,000	55	5,000	4			33	43					
Nov. 29 Entered Hospital	2,100,000	50	8,900								98	1.4	
Nov. 29 Repeated				2	0	0	2	3	2	0	91		Blood clots rapidly. Red cells stain slightly. No large red cells; few small ones. Moderate anisocytosis, poikilocytosis.
Nov. 30	1,860,000	53	9,500	3	0	0	1	3	2	0	91	1+	Majority of leucocytes contained many large black staining granules. Bleeding time 3.5 min. Clotting time 2 min. Blood culture negative.
Dec. 1	2,780,000	55	5,400									1+	
Dec. 14	1,750,000	52	1,260	2								1.5	Platelet count 40,000 cells; highly colored R.B.C. No noticeable anisocytosis or poikilocytosis.
Dec. 5	1,900,000	55										1.4	
Dec. 7	2,240,000		1,800	25	0	0			0	15	60	1.2	Platelet count 50,000

either group and had to be placed in an undetermined class. The majority, however, could be definitely placed in either the ulcer or cancer classification.

serial roentgenograms is essential for the determination of early roentgen gastric changes. These present the only means of pointing out the slight changes in the

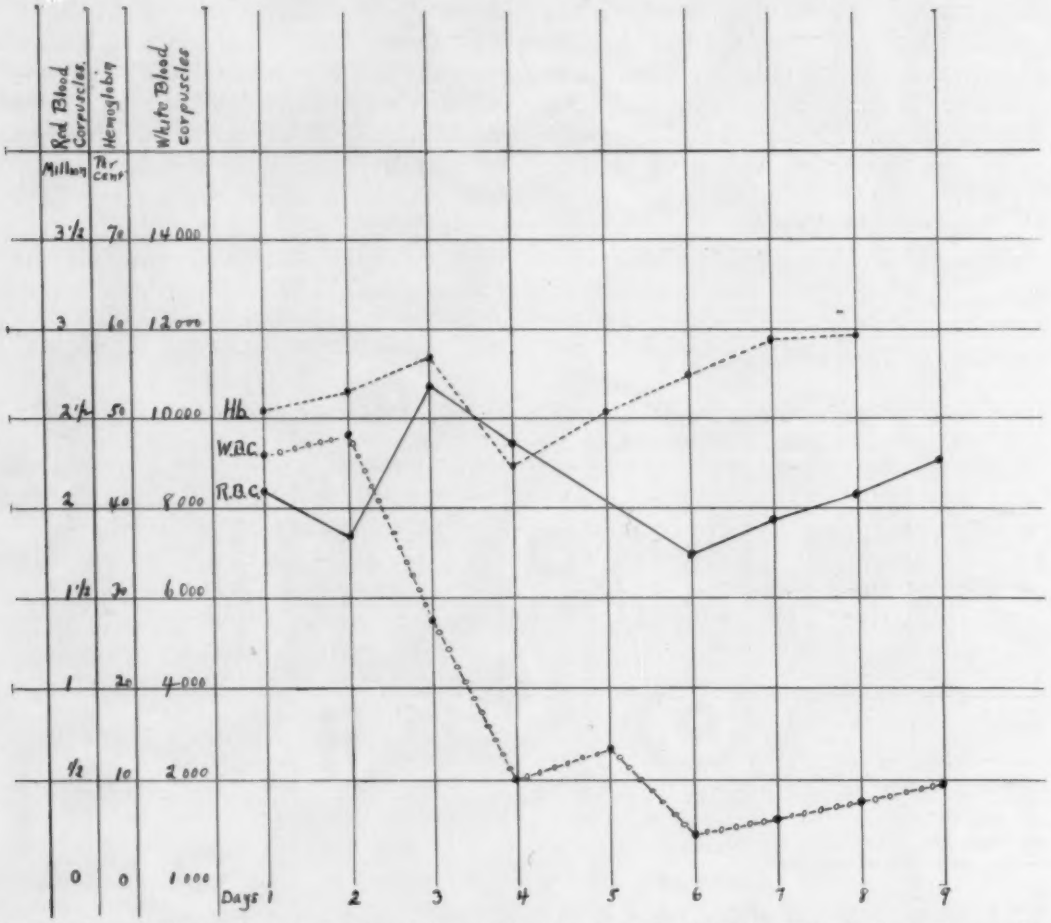

Chart 1. Case 1. Illustrates the relation of the red blood corpuscles, white blood corpuscles and hemoglobin. (From the records of the Johns Hopkins Hospital.)

In the routine gastrointestinal roentgen study of the stomach a thorough roentgenoscopic examination is required. It is of interest to note that in this examination the change in the gastric configuration at times may not become apparent to the observer and no intimation as to the true nature of the pathologic condition is presented. The roentgenoscopic examination reveals in most instances a normal picture of the stomach. This examination alone, however, should not be relied upon without the usual series of films. A group of

contour of the curvatures of the stomach. In order to establish with some certainty the diagnosis of a gastric lesion, these changes must be constant.

The most striking features of the indirect roentgen findings are the disturbance in the peristalsis, alteration in the shape and size, and rapid emptying of the stomach. The presence of some alteration in peristalsis, producing disorganization in the regular passage of the waves is probably the earliest possible change encountered in gastric disease involving the wall of the

stomach. As the condition progresses, the size of the stomach gradually becomes smaller and apparently shorter. These changes are best illustrated by means of serial roentgenography. Tracings of the stomach may be made, superimposing one film upon another in order to indicate graphically the variations in the peristaltic waves. In carcinoma it will be noted that the alteration in the peristaltic movements is so marked as to involve a considerable portion of the stomach. In the later stages the entire stomach may become affected

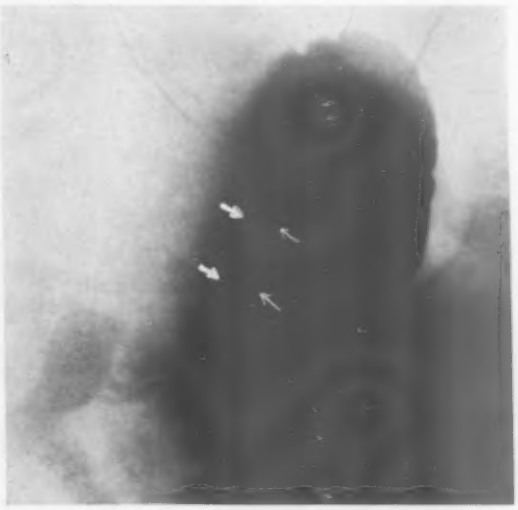

Fig. 1. Case 1. Roentgenogram showing an extremely small stomach, with a fixed area on the lesser curvature.

without, however, revealing the typical irregular displacing filling defect characteristic of this condition.

The early changes are principally due to the infiltration and induration, in addition to the surrounding associated inflammatory reaction.

The stomach becomes fixed in appearance, presents a stereotyped form, usually involves both curvatures, though in a few instances only a small fixed area may be observed. When both curvatures are affected, the stomach appears greatly shortened, is small in size and is situated high under the left diaphragm. The emptying time is markedly accelerated. The sphincteric equilibrium of the pylorus is also usually involved exhibiting a distinct pa-

Fig. 2. Case 1. A tracing from one of the roentgenograms.

tency. At this period there may not be any break in the regularity of the contour of the curvatures and no classical filling defect characteristic of carcinoma can be demonstrated. A palpable mass cannot be detected at this age. As the condition progresses, however, after a varying period of time, a further roentgen investigation may reveal a filling defect. When the cardia of the stomach is involved, esophageal invasion usually ensues. This had occurred in several instances in the late stage of our cases.

The changes in peristalsis, motility, contour, size and shape of the stomach do not, however, indicate the presence of

Fig. 3. Case 1. Tracings from a series of roentgenograms superimposed, illustrating a persistent fixed area on the lesser curvature.

carcinoma in all instances. These findings, moreover, point to a definite gastric lesion, the true nature of which cannot always be definitely determined. The foregoing gastric changes are all well recognized findings and no attempt is here made to indicate that they be regarded as new, but they are merely emphasized as important early changes which may lead to an early diagnosis.

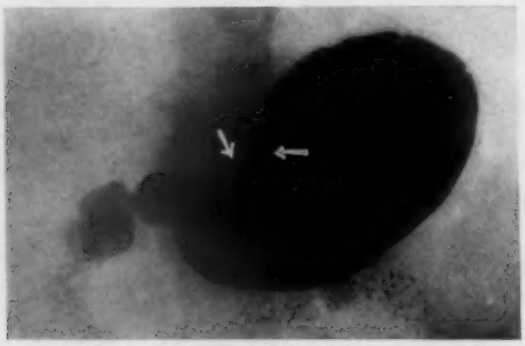

Fig. 4. Case II. Shows a small stomach with a persistent fixed area on the lesser curvature.

The following 6 cases are described which illustrate the diagnostic features of the roentgen changes observed in this group. Three additional cases have already been recorded.

Case I. Mrs. J. K., aged fifty-two, complained of pains in her stomach, vomiting, pressure in epigastrium, weakness and lump in throat. Her stomach symptoms began five years ago, at which time she had two attacks of severe pain in the right upper quadrant, associated with fever, jaundice and nausea. These attacks were relieved by a gallbladder operation, The gallbladder was found to be filled with stones. The appendix was also removed. Since then she had been free of abdominal symptoms until about one year ago when she began to complain of vague abdominal pains, coming on about ten to thirty minutes after eating, which were relieved by taking soda. She has had a number of these attacks during the year and each time they became more severe. Pains, anorexia and loss of weight became prominent symptoms. She entered the Johns Hopkins Hospital for observation, where a complete study was made.

On physical examination the patient was found to be acutely ill. The abdomen was slightly distended, liver edge palpable, spleen not palpable. No mass could be detected. Localized tenderness was elicited in the epigastrium. The roentgen examination (Figs. 1, 2 and 3) revealed an unusually small stomach, which emptied rapidly. Both curvatures showed a fixed, stereotyped appearance; the peristalsis was markedly diminished. No visible filling defect was observed. The duodenal bulb filled well. The roentgen changes in the stomach suggested an indurative lesion, probably malignant. The chest and long bones were negative. The interesting feature of this case is the blood picture. The blood revealed a reduction in erythrocytes, a reduction in hemoglobin, a progressive decrease in leucocytes a remarkably high percentage of myeloblasts in the differential count and a reduction in the platelet count. These blood changes are characteristic of a myelophthisic anemia and suggests a metastasis into the bone marrow. Clinically it was thought that this was a case of myelogenous leucemia. This pseudoleucemic blood reaction is not an uncommon observation in terminal carcinoma. Wassermann reaction was negative. Throat cultures and smears were negative. Gastric analysis revealed an absence of free hydrochloric acid and a total acidity of 6; no lactic acid; blood negative. The stools were watery and revealed occult blood. No autopsy was obtained in this case. The diagnosis was made from the roentgenological picture of an indurative lesion in addition to the absence of hydrochloric acid and the typical blood picture of a terminal metastatic carcinoma.

Case II. Mr. M. L., aged fifty-six, has had stomach trouble for thirty years. Three years ago he developed gastric pains, coming on about three hours after eating, which were relieved by food and soda. His appetite then was good, but he complained also of considerable distention. These symptoms disappeared under treatment. One year later his digestive symptoms returned. At this time a roentgen examination (Fig. 4) of the gastrointestinal tract was made and revealed a small fixed area on the lesser curvature of the stomach; no filling defect could be detected; the pylorus was regular; the duodenal bulb was normal; the colon was also normal. A roentgen diagnosis of a gastric lesion was made. The fixed area being small in size, occupying the usual site of an ulcer, suggested the possibility of a benign lesion and the

patient was therefore placed upon an ulcer regimen following which all gastric symptoms disappeared.

Seven months later, he again developed stomach symptoms, and upon re-examination the roentgen ray revealed a large irregular annular carcinoma of the pylorus with a large eighteen hour gastric retention (Fig. 5). A fractional analysis made of the gastric contents revealed an absence of free hydrochloric acid and a total acidity ranging from 6 per cent on a fasting stomach up to 15 per cent after twenty minutes. No lactic acid was obtained; no occult or free blood was detected. Stools revealed two-plus occult blood. At operation a large carcinomatous tumor was found with metastasis involving the omentum, peritoneum and liver.

Case III. Mr. A.E.L., aged fifty-four, complained for six months of pains in lower chest and poor appetite. A roentgen investigation of the digestive tract revealed a normal functioning gallbladder. The stomach showed a constant fixed area on the greater curvature. The pylorus was normal; duodenal bulb regular; colon normal. The changes in the stomach suggested a gastric lesion, but at this time this case could not be classified roentgenologically as either malignant or benign. Gastric analysis revealed a free hydrochloric acid of 26 and a total acidity of 50. He was placed on the usual ulcer treatment and the symptoms disappeared.

Eight months later the condition returned,

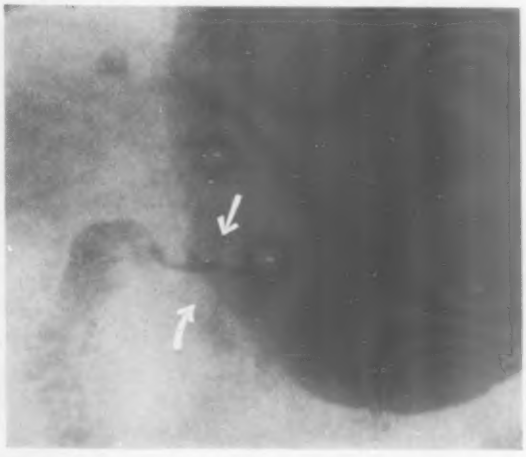

Fig. 5. Case II. A roentgenogram seven months later, showing a large annular carcinomatous filling defect at the pylorus, the lesion extending up into the antrum.

with an additional symptom of loss of weight. At this time a re-examination (Fig. 6) showed a small stomach, located high under the left diaphragm; it emptied rapidly; the curvatures

Fig. 6. Case III. Shows a carcinomatous irregularity in cardia of the stomach. Roentgenograms made eight months previously revealed a small fixed area on greater curvature suggestive of a gastric lesion.

showed a stereotyped or fixed appearance. The cardia of the stomach was narrowed and irregular; pylorus and duodenal bulb were regular; colon normal. A roentgen diagnosis of gastric carcinoma was made and at operation a large carcinomatous tumor was found. The gastric analysis at this time showed a free hydrochloric acid of 18 and a total acidity of 34. These high acid findings are not an unusual observation, especially in the early stages of carcinoma of the cardia of the stomach.

Case IV. Mr. H.S.K., aged fifty-nine, complained of stomach trouble for seven months with abdominal pains, having no relation to food; poor appetite; slight difficulty in swallowing and slight loss of weight. A gastrointestinal roentgen investigation (Fig. 7) revealed a small, rapidly emptying stomach. A small fixed area was observed on the lesser curvature, but no typical filling defect of an organic lesion could be detected. The pylorus was regular; duodenal bulb normal; second portion of the duodenum was markedly dilated as a result of adhesions. A diagnosis of gastric lesion of undetermined nature was made. A test meal showed an absence of free hydrochloric acid and a total acidity of 21. His symptoms became progressively worse and about six months later an exploratory operation revealed a carcinoma of the stomach.

Fig. 7. Case iv. Shows a small stomach with fixed curvatures; empties rapidly. No demonstrable filling defect observed. Case proved to be a carcinoma.

Case v. Mrs. C. J., aged forty, compained of indigestion for two years. Recently she began to lose weight, with abdominal distention, poor appetite, constipation and belching. She has had no pain and no vomiting. The gastric contents at this time revealed an absence of free hydrochloric acid and a total acidity of 18. A roentgen examination of the gastrointestinal tract showed an unusually small stomach, which emptied rapidly; the cardia appeared somewhat narrowed, but no typical defect could be detected (Fig. 8). The lesser curvature showed a fixed area suggesting a gastric lesion of the

Fig. 8. Case v. Showed a small, rapidly emptying stomach, with narrowing of the cardia. Proved to be a carcinoma.

malignant type. At operation a carcinoma of the stomach was found.

Case vi. Mr. T. D., aged forty-two, complained of recent pains in the epigastrium with no relation to food; poor appetite; a gnawing sensation in stomach, and constipation. A roentgen examination (Fig. 9) made at this time revealed a small stomach which emptied rapidly. The stomach had a fixed, stereotyped appearance, with definite lack of peristaltic movements. No definite filling defect was observed. The lesser curvature, however, showed a small straight line effect; the pylorus was found to be patent and regular; the duodenal bulb appeared moderately dilated; the second portion of the duodenum also revealed a slight dilatation. The roentgen changes in the stomach sug-

Fig. 9. Case vi. Showed a small rapidly emptying stomach, with a fixed area on lesser curvature. No demonstrable filling defect is observed. Proved to be a clinical case of carcinoma of the stomach.

gested a malignant condition without the usual characteristic filling defect. The patient died of a general carcinomatosis.

This group of cases was followed for many months and had been re-examined on repeated occasions. The diagnosis of carcinoma in the entire group was verified by either operative or clinical-roentgenological procedures. Six cases came to operation. The remaining three presented a definite clinical and roentgenological picture of carcinoma of the stomach with later development of palpable masses. The entire group of 9 cases died of a malignant condition.

CONCLUSIONS

An attempt is made to present the early roentgen findings in a group of cases in which the diagnosis of carcinoma of the stomach had been definitely established. These cases presented no demonstrable roentgen filling defect characteristic of carcinoma. The importance of the indirect or secondary roentgen signs, viz., changes in peristalsis, motility, contour and size of the stomach and their effect on the curvatures as revealed by means of serial roentgenography are stressed as early roentgen signs of gastric pathology. It is also pointed out that changes in the early stage of gastric disease may not be revealed by the roentgenoscopic examination and that on this account serial roentgenography with careful study of the peristaltic waves along the curvatures is essential. In order to definitely establish the diagnosis, repeated roentgen examinations are often of the greatest value. A diagnosis of a gastric lesion is therefore at times possible many months preceding the visualization of a filling defect. From a study of this group of cases. I am thoroughly convinced that these roentgen signs, no matter how slight they may be, emphasize anew the increasing importance they command as a means of arriving at an early diagnosis of gastric carcinoma.

THE ROENTGENOLOGIC IDENTIFICATION OF COMMONLY ENCOUNTERED CHRONIC ULCERATIVE DISEASES OF THE COLON*

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IN THE north temperate zone three types of chronic, nonmalignant ulcerative disease of the colon are ordinarily encountered: diplostreptococcic, tuberculous and amebic. If other types occur they are rare, or their nature is not readily determined, so that for practical purposes they do not come under consideration before these three more prevalent types are definitely excluded in the diagnosis. It is often possible, from a carefully made clinical appraisal, not only to recognize the presence of one of these diseases, but to point to its probable etiology. But for a precise and conclusive diagnosis, the physician must resort to the objective data made available to him by one, not infrequently by all, of the three key diagnostic procedures essential to adequate rectal and colonic diagnosis: proctoscopy, gross and microscopic analysis of stools and rectal discharges, and roentgenologic examination. Of these, the last named is by no means the least important, for only a limited portion of the bowel comes within proctoscopic range, and examination of the stool and rectal discharges may fail to disclose significant findings. It is my purpose here to consider the roentgenologic methods of examination as applied to investigation of these diseases, to describe the roentgenologic manifestations of chronic ulcerative disease of the colon in general, and to point out roentgenologic characteristics which have been found useful in distinguishing these particular diseases of the large intestine from one another.

ROENTGEN METHODS OF INVESTIGATION

The observation of the opaque meal in its progress through the intestinal tract, to study alterations in intestinal motility, has been advocated as a method of investigation particularly efficacious in this group of diseases. It is not the method of choice in the Section on Roentgenology in The Mayo Clinic, because of the conviction that the evidence of disease it delivers is largely indirect, and hence of diminished diagnostic value when compared with the direct evidence of disease elicited by other methods. A local or general increase in intestinal motility is to be expected in all types of chronic ulcerative colitis. If the ulcerative process is diffuse and extensive, transportation of the opaque meal through the large intestine is markedly accelerated. If, on the other hand, the disease involves only a relatively short portion of the bowel, the increase in rate of transportation is restricted to involved and immediately adjacent segments, whereas the unaffected intestine does not exhibit any acceleration in motility. Bargen[1,2] has repeatedly called attention to a noteworthy exemplification of this occurrence in cases of the diplostreptococcic type of ulcerative colitis, in which the disease is confined to the most distal segments of the bowel. Rectal discharges of pus, blood and mucus may be numerous, yet the patient may complain of constipation, and the stools may be scybalous. This indicates retarded colonic motility, in spite of ulceration and consequent hyperirritability of the involved rectum and sigmoid.

The phenomena of local or general hypermotility have never been looked on as intrinsically pathognomonic of any single type of ulcerative colitis. Even if considered in association with other relevant laboratory or clinical data, as for instance

* Read at the Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27–30, 1932.

the coexistence of an active focus of tuberculosis in the lungs, or the presence of *Endamoeba histolytica* in the stool, these phenomena cannot be said, in a strict sense, to constitute anything more than presumptive evidence of a specific disease. When rigidly controlled, however, as is the method of recognizing intestinal tuberculosis advocated by Brown and Sampson, roentgenologic evidence of local or general hypermotility is not easily disregarded.

In the Section on Roentgenology in The Mayo Clinic roentgenoscopic observation of the opaque enema is the cardinal procedure in investigation of all types of disease of the large intestine, malignant and benign. The requirements in individual cases may demand that examination of the colon be extended to include other roentgenologic procedures, of which the most commonly employed are roentgenography of the bowel distended with the opaque clysma, and special examination of the mucosa and the internal topography of the bowel by roentgenoscopic and roentgenographic examination after the opaque enema is evacuated, both before and after distention with air or some other inert gas. These are looked on as auxiliary maneuvers, which complement but do not supersede the roentgenoscopically controlled administration of the opaque enema. As a matter of principle, any method or combination of methods should be employed to make rendition of a complete and precise diagnosis possible. Roentgenoscopic observation of the opaque enema is designated the cardinal method, because from the diagnostic data it yields, the indications for extension of the examination to include more refined techniques can be inferred. The advantages it offers seem obvious. Exact information regarding mobility, flexibility, and the character and persistence of irregularities in contour is made available. The entire organ can be viewed as a unit in its living state, or any part of it can be subjected to separate visual and manipulative scrutiny at any instant, from any desired angle. In most instances of organic disease of the colon, it is possible to elaborate a pathognomonic roentgenologic syndrome from the data elicited in this phase of the examination alone.

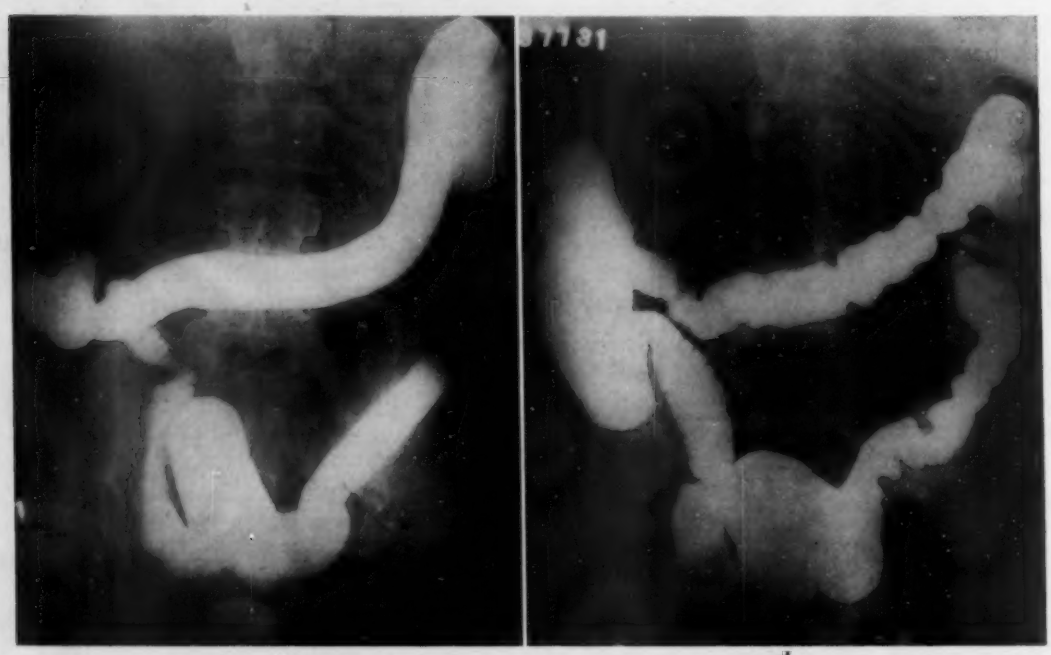
Any technique of administering the opaque enema for roentgenologic examination is permissible as long as it provides for visualization of every part of the large intestine, and permits simultaneous manipulation of the bowel whenever this is necessary or helpful. The technique in use at The Mayo Clinic has repeatedly been described.[13,14] It is hoped that a word of exhortation about the preparation of the bowel for the examination will not be considered superfluous or out of place. It is important that even in the presence of severe ulcerative disease of the colon, with frequent stools, some special effort should be made to cleanse the lumen of the bowel of excessive quantities of gas, intestinal secretion, and fecal material. Paradoxical as it may seem, these are almost always present in the unprepared colon in quantity sufficient to interfere with securing ideal diagnostic results from the roentgenologic examination. Drastic catharsis is of course contraindicated if patients have active diarrhea, or if the ulcerative process is in an acute, fulminating stage. A mild, nonsaline cathartic drug, supplemented by a few warm enemas of physiologic saline solution, is a commendable preparatory measure.

ROENTGENOLOGIC DIAGNOSIS

General Considerations. Anatomically, chronic ulcerative colitis of any type produces some degree of narrowing, shortening, mural thickening, and mucosal destruction in the affected portion of the intestine. The intensity of the changes produced varies with such factors as the duration of the disease, its virulence, the general resistance of the patient, and the extent of secondary infection. The changes in the mucosa are macroscopically distinctive so that direct inspection of the mucosal aspect of the bowel usually, but not invariably, makes possible identification of the type of ulceration. The other macroscopic features,

on the other hand, are not essentially pathognomonic, since the pathologic processes by which they have been developed are essentially the same, whatever the etiology of the disease. If roentgenologic diagnosis is to have a rational basis, the signs elicited should reflect the anatomic changes produced as a result of, or in association with, the underlying pathologic process. Pathognomonic roentgenologic characteristics of the ulceration in the group of diseases under consideration have not, to my knowledge, been described. The alterations in the bowel that are roentgenologically demonstrable, however, are general contraction, which implies narrowing and shortening; mural thickening revealed by increased resistance to palpation; diminished mobility and flexibility, and destruction of the mucosa revealed by marked changes in its relief. Of invaluable differential diagnostic significance are such roentgenologically recognizable features as the site of apparent earliest and severest involvement, the distribution of the process and its method and direction of extension, the general intensity of the disease, and roentgenologic findings in other organs. The command, "Look at the four corners of the film," which is said to have been originated by Hickey, is particularly pertinent in the differential diagnosis of this group of colonic diseases.

Chronic Diplostreptococcic Ulcerative Colitis. The term "chronic ulcerative colitis" by which the disease is widely known is inadequate because not sufficiently specific. I use the word "diplostreptococcic" to specify that particular type of chronic ulcerative colitis with which Bargen's bacteriologic investigations have chiefly been concerned. Associated with this disease is a pathognomonic proctologic picture described in detail by Buie and others, and a roentgenologic syndrome which is no less characteristic and specific. Bargen has made out a plausible case for the specific etiologic part played by the diplostreptococcus he isolated and described, and his



a *b*

Fig. 1. Chronic diplostreptococcic ulcerative colitis. *a.* Narrowing, shortening, mucosal destruction and absence of haustral markings are characteristic of all ulcerative colonic disease; that the disease progressed orad from the rectum is characteristic of chronic diplostreptococcic ulcerative colitis. *b.* After treatment for ten months; the normal appearance is tending to return.

work is supported by Soper, Fansler, Jones, Torrey, Chisholm and others. It is also apparent, however, that other organisms, as secondary invaders, contribute not a little to the pathogenesis of the disease.

Since the rectum is the site of primary and severest involvement, the proctoscope delivers the most direct and reliable diagnostic information. Roentgenologic examination determines the extent of the process beyond the range of the proctoscope, reveals the presence or absence of complications, and offers the only objective evidence of the presence of the disease in those comparatively rare instances in which the rectum has not been primarily involved.

As has been stated, roentgenologic evidence of narrowing, shortening, mural thickening and mucosal destruction is common to all types of chronic ulcerative colitis. These changes are expressed more intensely, however, in the diplostreptococcic than in the other types. The severest involvement is seen in the most distal portions of the bowel, the rectum and sigmoid, and tends gradually to diminish in intensity from below upward. The manner in which the disease progresses proximal from the site of primary attack is vividly reflected in the roentgenologic picture, and this makes up one of the most important differential diagnostic features; in fact, it is the only morphologic differential characteristic when distribution of the disease is atypical. Characteristic of the diplostreptococcic type of ulcerative colitis is the diffuse, symmetrical involvement of the circumference of the bowel (Fig. 1) and a creeping, pedetentous, dogged type of advance from segment to segment. This is the pathologic background for the roentgenologic features of the disease: diffuse, concentric, uninterrupted, narrowing, shortening, thickening of the walls and mucosal destruction.

The disease is confined to the rectum in 20 per cent of the cases;[3] the entire colon and terminal part of the ileum may be involved, or the advance of the disease may be checked at any point between the rectum and cecum. Chronic diplostreptococcic ulcerative colitis, without rectal involvement, is found in scarcely more than 5 per cent of all cases encountered in The Mayo Clinic.

Smooth contours and subdued or absent haustral markings do not constitute an adequate basis for a diagnosis of ulcerative colitis. It is true that the roentgenographic outline is unusually smooth and straight when the ulceration is granular and superficial, but when the ulcerative process extends deeper, and mucosal destruction is more severe, the contours are uneven, fringed, and feathery (Fig. 2). In the same way the mucosal surface may be very smooth and flat, devoid of every vestige of relief, or it may be irregularly corrugated, rough, and uneven.

Fig. 2. Chronic diplostreptococcic ulcerative colitis, acute fulminating stage. Deep submucosal excavations are revealed by niche-like projections from the luminal shadow. Narrowing and shortening have not had time to develop.

The typical picture of this type of chronic ulcerative colitis has frequently been described. Rapid filling of the bowel by rectum and hyperirritability of involved seg-

ments are associated with the signs already considered. The course of the bowel has a tendency to lose its gently twisting character, and normal angulations at the flexures and elsewhere approximate right angles. Variations from the entirely typical picture are sometimes encountered, but, as a rule the roentgenologic picture is uniform, and need practically never be confounded with that of any other known disease of the bowel.

Fig. 3. Hyperplastic ileocecal tuberculosis revealed by the double contrast method. Deformity of the cecum and abrupt narrowing of the terminal portion of the ileum are evident. Diagnosis was confirmed at operation.

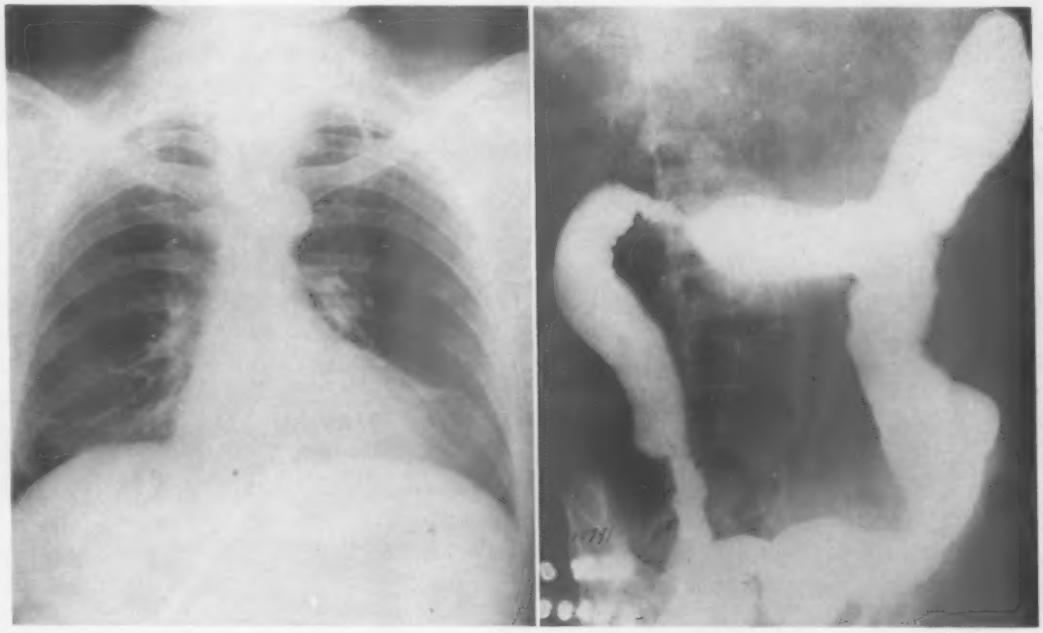
Tuberculous Ulcerative Colitis. It is generally agreed that the ileocecal portion of the intestinal tract is the most common site of tuberculous intestinal involvement, and that the earliest lesions are invariably found there. Most observers suppose that the infection originates with ingestion of infectious tuberculous material. The predisposition of the ileocecal region seems to be associated with its abundance of lymphoid tissue, to which the bacillus of tuberculosis is notoriously partial, and with the low ebb of the fecal current in this region, which enhances the organism's opportunity to gain a foothold. Tuberculous ulceration is most frequently found in the ileum, near the ileocecal valve, and may not extend into the colon. On the other hand, involvement may be confined to the cecum and proximal segments of the colon, with a sharp interruption of the process at the ileocecal orifice. However, combined involvement of the terminal portion of the ileum, cecum and ascending colon is by far more commonly encountered.

Early in its development the tuberculous intestinal ulcer is a discrete, circumscribed lesion. Extensive involvement seems to take place by development of multiple, separate ulcers with eventual coalescence, rather than by a creeping type of extension from a primary focus, as is the case with the diplostreptococcic type of chronic ulcerative colitis. The result is a tendency toward irregular involvement of the circumference, and an interrupted rather than continuous extension in the direction of the longitudinal axis of the bowel. It is probable that extension caudad takes place much more readily than retrograde extension; the diplostreptococcic type of ulcerative colitis, on the other hand, seems capable of extending in either direction with almost equal facility.

It is customary to distinguish between the hyperplastic and ulcerative types of intestinal tuberculosis. The former is often, the latter rarely, primary in the intestine. The hyperplastic type of intestinal tuberculosis is definitely a tumefactive, granulomatous process, localized to a relatively short portion of the bowel, usually to the ileocecal coil (Fig. 3), less commonly to more distal segments, and is formative rather than destructive. Sometimes, however, the predominance of the hyperplastic reaction is not so marked, and the tuberculous process exhibits so many elements of both forms, that a sharp line of distinction cannot be drawn. As a rule, however, the hyperplastic type of intestinal tuberculosis will demand differential identification from

neoplastic disease and other forms of granulomatous involvement rather than from one of the types of chronic ulcerative colitis.

Secondary involvement of the intestine with tuberculosis from some distant, active focus, especially the lungs, is so common (ulcerative) type of tuberculous enterocolitis has admittedly not been as large in The Mayo Clinic as elsewhere, but experience with other types of intestinal lesions makes me believe that evidence of anatomic change in the intestine can be elicited whenever such change is sufficiently exten-



a *b*

Fig. 4. Tuberculous ulcerative ileocolitis. *a*. The lungs in this case, contrary to the usual condition, are free of evidence of active tuberculosis. *b*. General evidence of ulcerative colonic disease is the same as that in Figure 1, but that the disease progressed caudad from the ileum is characteristic of tuberculous ulcerative ileocolitis. Diagnosis was confirmed at operation.

that any change, organic or functional, manifested in the intestinal tract, particularly in the ileocecal region, can perhaps more or less logically be interpreted as objective evidence of tuberculous involvement of that region. Foreknowledge of the existence of an active, primary tuberculous focus, therefore greatly simplifies the diagnostic problem. Sources of error, however, are numerous unless the evidence of intestinal involvement is carefully weighed and evaluated. Roentgenologic findings which mirror the anatomic changes in the intestine produced by the disease merit prime consideration. Experience with the secondary sive to effect recognizable functional abnormality.

Since the combined involvement of ileum, cecum, and colon is so typical of a tuberculous process, it is essential to subject the ileum to thorough roentgenologic examination. This is accomplished in the most satisfactory manner, and usually with ease, by retrograde, opaque filling through the ileocecal valve. Contraction, hyperirritability, and obliteration of mucosal relief are the principal roentgenologic signs of disease of the ileum, and are usually seen in the very terminal segments. Narrowing, shortening, hyperirritability, and mucosal

destruction again bespeak cecal and colonic involvement (Fig. 4). If the evidence of disease is found distal to the hepatic flexure, a patchy distribution is not infrequently seen, with relatively unaffected portions of bowel interposed between diseased segments. The contours of the shadow of the barium-filled lumen may be smooth or uneven, depending largely on the depth of ulceration. Narrowing of the lumen is usually marked, especially if a long segment is involved; the shadow, however, is not straight and tubelike, but tends to be unsymmetric and sharply irregular. Normal mucosal relief patterns are, of course, obliterated in the affected segments, and a rugged, irregularly arranged grouping of jagged prominences and depressions takes its place.

These are the principal differential characteristics of the deformity produced in association with tuberculous enterocolitis. Of prime diagnostic significance, however, is the evidence of initial and combined involvement of ileum, cecum and proximal part of the colon, with diminution in intensity of the extending process as the rectum is approached, and on this basis alone the distinction from the diplostreptococcic type is possible in the vast majority of instances. The differential identification from amebic ulcerative colitis is a more difficult task.

Amebic Ulcerative Colitis. According to Craig, who cited the opinion of other authorities to substantiate his own, *Endamoeba histolytica* is not found in the stool except in the presence of an amebic intestinal lesion. The estimate that between 5 and 10 per cent of the population of this country harbor *Endamoeba histolytica* is said to be conservative. This represents a high incidence of amebic disease, and in this light the poverty of the roentgenologic literature on the subject is surprising. It is true that the disease, as encountered in this latitude, is in relatively attenuated form; still, amebic dysentery is not altogether uncommon, and it does not seem unreasonable to expect some roentgenologic evidence of a lesion which is capable of causing such a degree of functional irregularity of the intestine.

The fact is that significant roentgenologic evidence of ulcerative colitis is elicited in at least some instances when *Endamoeba histolytica* is discovered in the stools, even in the absence of definite clinical evidence of intestinal disease. How uniformly this occurs cannot be stated at the present time, because the opportunity to examine all persons who harbor the parasite has not been offered. It is probable that positive roentgenologic findings will be found much more frequently than is suspected by many of those who deal with this group of patients clinically. If roentgenologic examination offered no more than objective evidence of the severity and extent of involvement, and of the effects of anti-amebic therapeutic measures, its application in all cases of amebiasis would seem justified. Not infrequently positive roentgenologic data will stimulate more intensive search for the causative parasite.

Anatomically, the cecum and proximal segments of the colon have been found to be sites where earliest and severest amebic ulceration is discovered. Secondary sites of preference are the dependent portions of the bowel. The ileum is notoriously free of involvement, although the cecal aspect of the ileocecal valve is frequently affected, which results in a gaping orifice due to stiffening of its lips. Essentially the same pathologic changes take place in the walls of the bowel as are seen in other types of ulcerative colitis, although the emphasis and degree of involvement displayed by other types at comparable stages are lacking. Extension of the disease beyond the site of primary involvement is not continuous, but tends to be interrupted, with the interposition of relatively unaffected segments between those that are diseased.

With this anatomic background, the roentgenologic diagnosis of amebic ulcerative colitis can be approached with reasonable hope of a measure of success. It is possible that roentgenologic evidence of

anatomic change in the colon will be discoverable among but a relatively small percentage of the carriers of *Endamoeba histolytica*, especially if minor deviations from normal roentgenologic appearances are permitted to pass unheeded.

The cecum demands particular attention (Fig. 5). It has been the site of maximal roentgenologic change in every instance in which I have offered a diagnosis of amebic ulcerative colitis. Suppression of haustral markings, shortening, and narrowing, sometimes to the extent of almost complete obliteration of the lumen, have uniformly been observed in the cecal segment. It does not seem that any degree of diagnostic significance should ordinarily be associated with so-called incompetence of the ileocecal valve. Slight manipulation of the ileocecal coil at the time when the cecum is moderately distended with the opaque enema usually effects reflux into the terminal part of the ileum. However, an unimpeded rush of opaque fluid observed to enter the ileum before even moderate distention of the cecum is accomplished is a signal for more than ordinary care in determining the presence or absence of cecal disease. With extension of the amebic ulcerative process beyond the cecum, the cardinal roentgenologic signs of ulcerative colitis are again exhibited, but not as emphatically as they are developed by the diplostreptococcic or tuberculous types (Fig. 6). Narrowing, shortening, and mucosal destruction are not so intense. The wall of the bowel is relatively pliant and freely movable. The entire roentgenologic aspect of the disease is one of diminished intensity and severity, when compared with the manifestations of the other types of chronic ulcerative colitis.

Fig. 5. Chronic amebic ulcerative colitis. Narrowing and shortening are confined to the cecum. The terminal portion of the ileum gave no evidence of organic change at roentgenoscopic examination. *Endamoeba histolytica* were found in the stool.

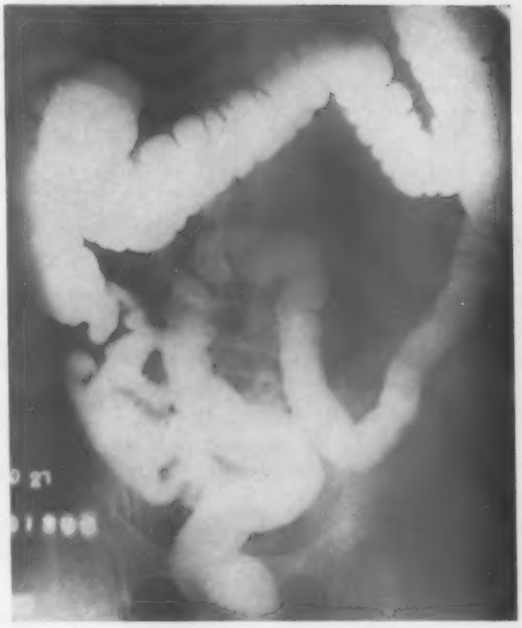


Fig. 6. Chronic amebic ulcerative colitis. Amebic ulcers were discovered in the rectum at proctoscopy, and *Endamoeba histolytica* were found in the stools. The general manifestations of chronic ulcerative colitis are apparent, but the intensity of the involvement decreases as the rectum is approached. Roentgenoscopically no evidence of disease was demonstrable in the ileum.

Because of the wide divergence of therapeutic measures applied in the manage-

ment of this group of diseases of the large intestine, it is particularly essential that an accurate etiologic diagnosis be established. No single, diagnostic method is capable of accomplishing this task unassisted in every case. Roentgenologic methods of investigation have an invaluable contribution to make to the diagnosis. Let roentgenologists and their medical and surgical colleagues attempt to appreciate the full complement of the evidence which these methods of investigation applied to the large intestine are capable of yielding. Not that roentgenologic investigation should be permitted to supplant any part of the carefully elaborated clinical survey of the patient. Rather let the correct diagnosis be reached by careful marshalling and judicious analysis of all available pertinent data, to the ultimate benefit of the patient.

REFERENCES

1. Bargen, J. A. The etiology and treatment of chronic ulcerative colitis. Am. J. Roentgenol. & Rad. Therapy, 1926, *16*, 10–16.
2. Bargen, J. A. The treatment of chronic ulcerative colitis. *Minnesota Med.*, 1927, *10*, 689–694.
3. Bargen, J. A. The medical management of chronic ulcerative colitis. *Tr. Am. Gastro-Enterol. Ass.*, 1927, 145–159.
4. Bargen, J. A., and Weber, H. M. Regional, migratory chronic ulcerative colitis. *Surg., Gynec. & Obst.*, 1930, *50*, 964–972.
5. Brown, Lawrason, and Sampson, H. L. Intestinal Tuberculosis. Second edition. Lea and Febiger, Philadelphia, 1930, 376 pp.
6. Buie, L. A. Chronic ulcerative colitis. *J. Am. M. Ass.*, 1926, *87*, 1271–1274.
7. Chisholm, A. J. Symptomatology and treatment in chronic ulcerative colitis. *Colorado Med.*, 1928, *25*, 28–31.
8. Craig, C. F. The amebiasis problem. *J. Am. M. Ass.*, 1932, *98*, 1615–1620.
9. Fansler, W. A. Chronic ulcerative colitis. *M. J. & Rec.*, 1927, *126*, 427–430.
10. Jones, D. F. The surgical treatment of chronic ulcerative colitis. *Tr. Am. Gastro-Enterol. Ass.*, 1927, 172–179.
11. Soper, H. W. Chronic ulcerative colitis. *Ann. Int. Med.*, 1927, *1*, 313–350.
12. Torrey, J. C. Bacteriology of the human colon with particular reference to ulcerative colitis. *Tr. Am. Gastro-Enterol. Ass.*, 1927, 129–135.
13. Weber, H. M. Chronic ulcerative colitis: its roentgenologic manifestations. *Med. Clin. N. Am.*, 1930, *13*, 1461–1472.
14. Weber, H. M. The roentgenologic demonstration of polypoid lesions and polyposis of the large intestine. Am. J. Roentgenol. & Rad. Therapy, 1931, *25*, 577–589.

Vol. XXX, No. 4

DOUBLE PENIS AND DOUBLE BLADDER

WITH REPORT OF A CASE*

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DIPHALLUS, or duplication of the male external genitalia in whole or in part, is a relatively uncommon disturbance of development. In the medical literature, 3 cases were reported in the seventeenth century, 5 in the eighteenth, 22 in the nineteenth, and 15, including the case reported herewith, in the elapsed portion of the twentieth century. This total of 45 cases observed in a span of nearly 325 years probably does not represent with any great degree of accuracy the actual number of occurrences of this monstrosity, since this malformation is one over which an individual would tend to preserve an air of secrecy. It is equally true, however, that there must have been few cases observed which were not reported.

The first recorded case of diphallus was described in 1609 by J. J. Wecker[26] and was mentioned again in the same year by Schenkius.[18] Neugebauer[15] published in 1898 an excellent discussion of this malformation briefly summarizing all of the cases that had previously been reported. There were 28 cases in this series. Since that time 16 cases have been reported and inasmuch as no complete compilation of these has been made, we shall briefly summarize them herewith.

Case 29. Volpe.[25] See below.

Case 30. Keppel[8] reported a case of diphallus in a young male, aged twelve. Both penes were complete. The left was used for the sexual act, and the right for micturition.

Case 31. Beck's case,[2] observed in a five weeks old child, had two penes springing from one stalk at the symphysis. There were two meati, but no true urethrae. Erectile tissue was present in the penes. The scrotum was divided into two lateral compartments by a broad scrotal raphe. There was an associated exstrophy of the urinary bladder with a pair of functioning ureteral orifices on either side of the trigone.

Case 32. Lorthioir[13] reported a case of complete double penis. Each had a urethra and each was capable of erection. The scrotum was bifid but neither testicle had descended.

Case 33. Heller[7] described a case in which a double glans penis arose from a single shaft. These contained blind meati. A hypospadias was present under the right false meatus. The scrotum was normal, and no anomaly of internal organs was noted.

Case 34. Ribera[17] See below.

Case 35. Lionti[17] reported a case of double glans penis, the left meatus being impermeable, and the right leading through a single urethra to a normal bladder. The scrotum and its contents were normal.

Case 36. Trenkler[22] observed a case of double penis in which the corpora cavernosa were separated widely by a midline fault of the corpus spongiosum urethrae so that the urethral orifice lay in the perineum at the apex of the angle formed by the diverging corpora cavernosa. Each glans was nearly perfect. The scrotum and its contents were normal.

Case 37. Vaudescal's case[24] had a balanic hypospadias on the left. On the right of the midline was a supernumerary penis with a blind meatus. The scrotum was bifid, the right compartment containing no testis. The pelvic viscera were normal.

Case 38. MacLennan[14] reported a case of complete hypospadias over which hung a duplication of the glans penis. There was one scrotum containing two testes. The bladder sphincter was active and there was no incontinence of urine. An abnormal mass of tissue lying below the hypospadic urethral orifice was found to be rectal epithelium.

Case 39. Bruni.[4] See below.

Case 40. Bókay[3] described a case of exstrophy of the urinary bladder with total epispadias. There was a double glans penis, the right exhibiting neither meatus nor urethra, and the left containing a meatus without underlying urethra. The scrotal raphe was broad, dividing the sac into two lateral compartments, each of which contained a testis.

Case 41. Kimura's case[9] was a newborn with atresia ani and cor biloculare in addition to a duplication of the glans penis on a single shaft which internally contained two reduplicated shafts (i.e., four corpora cavernosa and two corpora spongiosa urethrae). The double urethrae became fused to form one passage in the region of the colliculus seminalis. The scrotum was tripartite, with a testis in each of the lateral compartments, and an empty pouch posteriorly. The bladder, prostate and seminal vesicles were normal.

Case 42. Tschmarke[23] described a case which pos-

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sessed two complete penes, of which the right alone contained a complete urethra and was capable of erection and ejaculation. The left glans had a blind meatus and no prepuce. The scrotum was divided incompletely into a semblance of two sacs, each of which contained a testis. The left side of the prostate was larger than the right.

Fig. 1.

Case 43. Harrenstein[6] reported a case in which there were two completely formed penes, each containing a urethra which led to a common bladder. Between the penes lay one compartment of the scrotum containing a testis. To the right of the right penis lay the other half of the scrotum with no contained testis. There was believed to be only one prostate.

Case 44. Seth and Peacock,[19] have recently reported a case in which the right penis was fully formed with prepuce, meatus, and urethra demonstrating slight hypospadias. There was no prepuce or urethra on the left, but there was a rudimentary meatus. The scrotum was single, containing both testes. Both penes became erect with sexual excitement. Pyelograms suggested a bifid right renal pelvis. Roentgenograms of the spine demonstrated several anomalies; lumbarization of the first sacral segment, congenital non-union of the lamina of the first sacral vertebra, and a right first lumbar rib.

Case 45 is described herewith:

Case 45. R.S., No. 181994, a white male, aged six, is a child of apparently healthy parents. Six siblings are living and well. There were three miscarriages in addition, the last one a seven-month fetus with atresia ani. At the time of the birth of our patient, the attending physician believed the child to be a female because of the marked edema of the perineum, and the child was given a female name. At the age of one year he was brought to the University Hospital for the first time, and on that admission the correct diagnosis of diphallus was made. The general physical examination is negative for other anomalies. Routine blood and urine studies are in no way abnormal. The blood Kahn is negative. The blood non-protein nitrogen value is 27.5 mg. per 100 c.c.

Examination of the genitalia (Fig. 1) reveals a duplication of the glans penis on a single stalk which measures 1 cm. in length. The glandes are symmetrical, perfectly formed, but contain rudimentary meati which admit only the tip of a probe. Each glans is provided with a frenum. One prepuce encircles the two glandes. There are two corpora cavernosa, the extremity of each being capped by a distinct glans. The scrotum is widely cleft, encircling the penis above, and curving down laterally in the form of an inverted U. The lateral pouches each contain a single testis which lies considerably below the tendon of the musculus adductor longus. Between the base of the penis and the anal margin there is an irregular mass of tissue. Near the lateral borders of this mass and immediately below the root of the penis is a narrow cleft on each side which admits a No. 16 catheter (Fig. 2). The catheters traverse a course inward and mesially for a distance of

Fig. 2. Catheters have been inserted in the urethral clefts.

2 cm. and open respectively into distinct right and left urinary bladders. Below the level of these orifices, and set just off the midline in the midst of the perineal mass of tissue on either side are pinpoint openings which are apparently the orifices of the ejaculatory ducts. An elevation occupies the midline below these openings. Rectal examination confirms the suspicion that this elevation is the prostate gland lying on the perineum. The rectal sphincter is intact. The patient is likewise continent of urine, voiding two simultaneous streams at will.

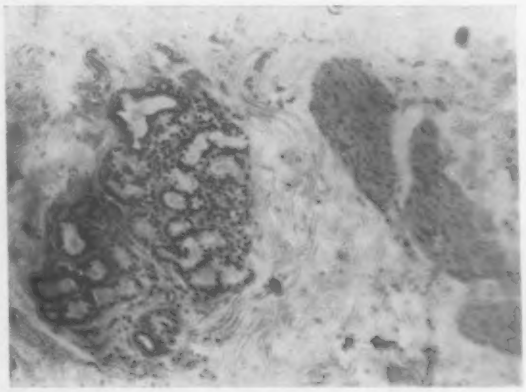

Fig. 3. Biopsy material demonstrating a nest of glands of paraurethral type. The epithelium is low columnar with basally placed nuclei.

Fig. 4. The greater portion of the perineal mass is covered by a simple columnar glandular epithelium resembling rectal mucous membrane.

Cystoscopic examination reveals that each bladder is a distinct organ, with no intercommunication between the two. The bladder mucosa appears normal and the single ureteral orifice in each bladder is normal. There is no trigone in either bladder. A No. 5 olive tip ureteral catheter passes easily to the renal pelvis, and retrograde pyelography with the aid of organic iodide demonstrates no abnormality of the upper urinary tract. Cystographic studies demonstrate the duplication of the urinary bladder and the imperforate midline septum (Fig. 5).

The ovoid prominence seen on the right at the lower border of the perineal mass (Fig. 1) was removed for pathologic study. This was reported as "stratified squamous epithelium underlaid by numerous bundles of smooth muscle; also numerous small glands of paraurethral type, some of which are mucin-forming" (Fig. 3). A small tag lying in the midline posteriorly was excised. This proved to be rectal mucous membrane (Fig. 4). The perineal tissue thus is composed of the elements of periprostatic urethral structures.

This is the sixth case of associated diphallus and doubling of the urinary bladder where no demonstrable connection between the two bladders could be made out. It is the first case of diphallus associated with duplication of the urinary bladder in which the latter has been demonstrated roentgenographically.

The first case of this type was described by Smith[20] in 1878, and was included in Neugebauer's concordance of 28 cases of diphallus. There were in this instance two well-formed penes, each with a perfect urethra which led to symmetrically disposed bladders which had no intercommunication. The right bladder contained a calculus.

The second case was described by Lange[10] and was also included by Neugebauer. This was seen in a fourteen-day old child with atresia ani and double penis. The scrotum was divided into two parts by a broad scrotal raphe, and each sac contained one testis. The penes were well formed, and each had a normal urethra. At autopsy, the bladder appeared fusiform, and upon opening it, there was found a perfect division into two vessels which lay side by side and did not intercommunicate. In this septum lay the prostate and seminal vesicles. The ureters and kidneys were normal. From each bladder led a single urethra through its own penis. These urethrae did not intercommunicate at any point, but below the prostate there were individual communications between these and the rectum so that both feces and urine were emitted from the urethral meati.

Volpe[25] cited a variation of this severe form of dis-

Fig. 5. Roentgenographic demonstration of the double bladder following intravenous urography.

turbance. There were two penes, completely formed and lying side by side. Each was provided with a urethral meatus and a single urethra which led to a distinct bladder. There was but one kidney and ureter and this latter opened into the left bladder. There were two suprarenal capsules. There was a complete duplication of the colon, beginning at the ileocecal valve region. One colon opened into the right bladder, the other into the left. The scrotum was bifid but hung in the perineum. There was no testis on the right. Each penis was composed of two corpora cavernosa and one corpus spongiosum. There was no anal orifice. Lebrun[11] observed that this was a most exceptional case in that it presented a fusion of organs normally doubled, and a doubling of organs which are normally single.

The fourth case (Ribera[17]) presented two fully formed penes one lying above the other. Each was provided with separate urethral meati, urethrae, and bladders, between which there was no communication.

Bruni[4] added a further case, observed in a thirty-five year old male. There were two distinct penes, lying side by side, but possessing a half-cylindrical form. Each was provided with a meatus and a single urethra through which a No. 16 sound could be passed to distinct bladders lying to the right and left of the midline respectively. On each side there was a single kidney and ureter which led to the homolateral bladder. The scrotum was widely cleft and each compartment contained a testis. The anal orifice was represented by two distinct openings lying to the right and left of the midline. The prostate and seminal vesicles were normal, but the latter contained no spermatozoa.

An understanding of these developmental anomalies requires an analysis of the embryologic origins of the parts involved.

The primitive gut is divided into several regional parts, and from the terminal one of these, the hind gut, there grows ventrally an evagination into the belly stalk which is destined to become the allantois. That portion of the hind gut caudal to the allantois dilates to form the cloaca. The cloaca is separated originally from the outside by a doubled layer of epithelium, ectoderm on the outer side, and entoderm facing the cavity of the cloaca. Between the two layers of epithelium of the cloacal membrane there grows from the intermediate cell mass of each side a proliferation of mesodermal cells. These mesodermal components are the anlagen of all the mesodermal structures of the lower abdominal wall; the striated musculature, the vessels, the cutis, and the differentiated group of cells which coalesce at the ventral midline to form one genital eminence—the anlage of the penis. It becomes obvious that any failure of coalescence of the rudiments derived from the two sides will result in a failure of formation of this one genital eminence. The normal development of this single genital eminence is essential to the later development of a normal single penis. Ballantyne[1] published the picture of a fetus with gastroschisis and two genital eminences widely separated, unquestionably the end-result of the failure of midline fusion.

The cloaca is gradually separated into two parts by the invagination of its lateral walls. The larger ventral division becomes the urogenital sinus, and the smaller posterior one the rectum. When this division is complete, the partition is the urorectal

fold, and into it are imbedded the terminal collecting ducts of the mesonephros. The formed urinary bladder is not, as would be supposed, the developmental end-product of the urogenital sinus or the allantois.[16] It is, along with the ureters, the trigone, the prostatic urethra, the seminal vesicles and the ejaculatory ducts, the structural remains of the mesonephric duct system. There is one mesonephric duct (Wolffian) on each side. From each duct develops the bilateral structures enumerated above. It is the complete fusion of the vesical portion of the mesonephric ducts which produces the normal single urinary bladder. Any degree of incomplete coalescence produces the structural end-picture either of hourglass bladder, incompletely bifid bladder, diverticulum with one ureter opening into the diverticulum, or, as our case represents, completely doubled bladder.[21]

Below the forming genital eminence, the rudiment of the lower anterior abdominal wall breaks in the midline to produce a defect in the ventral boundary of the urogenital sinus. This is the primitive urogenital opening. As the genital eminence develops, this cleft is elongated and its slit-like lips are in part brought into apposition in the midline again so that they normally fuse in the greater part of their extent. The failure of fusion of these lips in greater or lesser degree results in hypospadias. Epispadias and extrophy, on the other hand, are the results of failure of fusion of the cloacal membrane or its breaking down. The separation of the symphysis concomitant with exstrophy means simply that the mesoderm of the somatopleure which normally grows between the two layers of the cloacal membrane failed to differentiate normally.

To recapitulate, the entire urogenital tract, with the exception of the apex of the bladder derived from the urogenital sinus (and even this is capable of midline defect) is derived from bilateral anlagen which by their fusion in embryonic life produce normally single end-products, the urinary bladder, the prostatic urethra, and the penis. Failure of this fusion inevitably results in varying degrees of reduplication of the organ in question. Double penis and double bladder become, from this ontogenetic point of view, the normal end-result of normal development of abnormally, incompletely fused anlagen.

The suggestion that double penis may be an atavism inasmuch as all snakes and lizards normally possess two complete external genitals is hard to appreciate in a serious light, for the crocodiles, an equally old line from the evolutionary point of view, present one single external genital.

Quite another point of view is represented by that of Taruffi[21] who holds that this anomaly is a teratoid structure classified among the double monsters. His hypothesis, that the pelvis in these cases is really two pelves and the sacrum the fusion of two sacra, is not supported by either roentgenographic evidence of widening of the sacrum or anatomic proof of such coalescence. No case included in this survey gives weight to the notion that double penis is a disomatous teratoid structure.

One might also look on this anomaly, as does Ballantyne, as a minor degree of duplication of the individual. This places double penis in the same classification with supernumerary digits.

REFERENCES

1. Ballantyne, J. W. Manual of Antenatal Pathology and Hygiene, 1905, p. 544 et seq.
2. Beck, C. A case of double penis, combined with exstrophy of the bladder and showing four ureteral orifices. *Med. News*, 1901, *79*, 451.
3. Bókay, J. Ueber Diphallie. *Jahrb. f. Kinderh.*, 1930, *127*, 127–136.
4. Bruni, C. Seltene Anomalie der Urogenitalorgane: doppelter Penis. *Ztschr. f. Urol.*, 1927, *21*, 193–195.
5. Cathelin, F., and Sempé, C. La vessie double. *Ann. d. mal. d. org. génito-urin.*, 1903, *21*, 339–358.
6. Harrenstein, R. J. Ein Fall von doppelter Entwicklung des Penis und Skrotums (Diphallie). *Beitr. z. klin. Chir.*, 1931, *154*, 308–314.

7. Heller, J. Zwei seltene Missbildungen des Penis; a) Diaphallus partialis, b) Verdoppelung der Harnröhre. *Ztschr. f. Urol.*, 1908, *2*, 612–617.
8. Keppel, J. W. A double penis. *N. York M. J.*, 1898, *68*, 710. *Progres méd.*, 1899.
9. Kimura, H. On double penis and its complications. *Japan M. World*, 1930, *10*, 63–66.
10. Lange, M. Ueber complete Verdoppelung des Penis, combinirt mit rudimentärer Verdoppelung der Harnblase und Atresia ani. *Beitr. z. path. Anat. u. z. allg. Path.*, 1898, *24*, 223–230.
11. Lebrun. Les urètres doubles. *J. d'urol. méd. et chir.*, 1912, *2*, 381–412.
12. Lionti, G. Ein Fall von Penisverdoppelung. *Deutsche med. Wchnschr.*, 1914, *40*, 393.
13. Lorthioir, J. Un cas teratologique rare. *J. de chir. et ann. Soc. belge de chir.*, 1901, *1*, 82–84.
14. MacLennan, A. Double penis. *Glasgow M. J.*, 1924, *101*, 287.
15. Neugebauer, F. L. *Monatschr. f. Geburtsh. u. Gynäk.*, 1898, *7*, 550; 645.
16. Prentiss, C. W., and Arey, L. B. Textbook of Enbryology. Third edition, 1923, p. 206 et seq.
17. Ribera, J. Acad. Roy., Madrid, March 4, 1911.
18. Schenkius, J. G. Monst. Hist., Francofurti 1609, 43.
19. Seth, R. E., and Peacock, A. H. Double penis. *Urol. & Cutan. Rev.*, 1932, *36*, 590–592.
20. Smith, A. P. *Tr. Med. & Chir., Fac. of Maryland*, 1878, 91.
21. Taruffi. Sull'ordinamento della teratologia, Bologna, 1896.
22. Trenkler, R. Ueber einen Fall vorkommener angeborener Penisspaltung (Doppelpenis). *Wien. med. Wchnschr.*, 1914, *64*, 1079–1082.
23. Tschmarke, G. Beitrag zur Kasuistik der Diphallie. *Beitr. z. klin. Chir.*, 1931, *151*, 631–637.
24. Vaudescal. Présentation d'un cas de malformation rare des organes genitaux externes (Diphallus). *Bull. Soc. d'obst. et de gynéc. de Par.*, 1921, *10*, 271–273.
25. Volpe, M. Dell' asta doppia. *Policlin.*, 1903, *10*, (*sez. chir.*), 46–52.
26. Wecker, J. J. Obs. med. rar. admirab. et monst., Francofurti 1609. Lib. 4. De partibus genitalibus. Pene gemino visus quidam. 577.

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TRAUMATIC CYST OF THE PANCREAS WITH INFILTRATION INTO THE WALL OF THE STOMACH CAUSING PYLORIC STENOSIS

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CYST of the pancreas is of such infrequency that few clinical studies of large series of cases have been reported in the literature. Judd states that of 723,397 patients admitted to the Mayo Clinic only 88 with cyst of the pancreas have been operated on. Körte in 1898 reviewed 121 cases from the literature.

Cyst of the pancreas may be found in almost any part of the abdominal cavity. Martin reported one behind the descending colon. In Judd's series one was found in the pelvis between the layers of the mesocolon and the sigmoid. Hulke cites a case in which the cyst was retroperitoneally burrowing toward the pelvis. Judd states that the most frequent location is in the lesser peritoneal cavity presenting between the stomach and the transverse colon and behind the gastrocolic omentum. The next most frequent site is between the stomach and the liver or protruding into the lesser peritoneal cavity behind the stomach.

In the diagnosis of cyst of the pancreas the character and the situation of the tumor are of great importance. The cyst usually presents as a smooth, hemispheric, more or less immobile mass with rather tense walls and situated between the ensiform cartilage and the umbilicus, usually in the midline or slightly to the left. In the 121 cases reviewed by Körte a tumor was felt in 114, sixteen of which were below the umbilicus. In Judd's series of 47 cases a tumor was felt above the umbilicus in 45.

Unless the cyst is in the tail of the pancreas, and even here adhesions may prevent mobility, it is as a rule immobile. Judd reports mobility in 11 of his 47 cases, 9 of which originated in the tail of the pancreas. A majority of the patients complain of a mass or a fullness in the upper abdomen. There may be a history of sudden or of slow development. Judd states that in 43 of his 47 cases there was pain and that in 24 of these cyst of the pancreas was the only lesion found. The pain may be acute or dull. From the usual location of the cyst it is to be expected that nausea, vomiting and jaundice would be frequently encountered. In the review of the literature by Körte, jaundice was reported in 9 of the 121 cases. Judd reports a history of jaundice in 13 of his 47 cases.

In the differential diagnosis, cysts of the liver, the spleen, the ovary, the omentum, and the mesentery, hydrops of the gallbladder, tumors of the kidney, retroperitoneal tumors and aortic aneurysm have to be considered.

In cyst of the liver there is a swelling in the upper abdomen which is continuous with liver dullness; this is also true of hydrops of the gallbladder, whereas in cyst of the pancreas there is usually a line of resonance between the cyst and the liver. Cholecystography is also a differential aid in many instances.

In cyst of the pancreas there is usually an area of resonance between this and the spleen to differentiate it from a cyst of the spleen. In large cysts of the ovary the history is often an aid in the differentiation since the ovarian cysts grow from below.

Since the body of the pancreas usually lies just behind the stomach on the level of the first lumbar vertebra it can be readily understood why a severe blow in the upper abdomen could cause damage to this organ. There was a definite history of injury in 23 of the 121 cases reviewed by Körte. In Judd's series of 47 cases reported in 1930 there was a definite history of injury preceding the onset of symptoms in 8 cases. The time limit between the accident and the onset of symptoms varied

Fig. 1. Roentgenogram showing gross defect in pyloric end of stomach.

from three days to six years. McWhorter reports that there was a history of abdominal injury in 15 per cent of the cases. Lazarus produced a hematoma by crushing the pancreas of a dog and six weeks later found a cyst "the size of a goose egg," containing a milky fluid. Warnock reported a pancreatic cyst in a boy seven years of age following a severe abdominal trauma. There does not seem to be any reasonable explanation for the latent period in the development of cyst following trauma. Mahorner suggests that after the injury to the pancreas and the initial hemorrhage, the ferments erode the tissue causing further hemorrhage and thus enlargement of the cyst. This suggestion may explain the formation of the cyst in the case here reported.

CASE REPORT

Mrs. C. E. E., aged twenty-seven, was sent in for roentgenologic examination of the gastrointestinal tract on October 7, 1931, at which time she gave a history of having received an injury on July 4, 1931, when she was jammed, while swimming, by a surf board just below the costal margin. This was followed by nausea and about an hour later by intense abdominal pain. An abdominal operation was done within six hours after the injury. The tissues around the lesser border of the stomach were found lacerated but the stomach had not been punctured. There was a steady improvement for six days following the operation when the lower part of the incision began to drain pancreatic fluid. The drainage was intermittent, sometimes none appearing for several days. It was noted that each time the drainage stopped the patient had intense pain in the right lower quadrant which was relieved when the drainage started again. Following long periods of drainage the patient would become very weak and nauseated. This was relieved by giving glucose in Ringer's solution intravenously. There was marked and almost constant tenderness in the epigastrium.

Examination showed a scar in the upper portion of the abdomen, a little to the right of the midline; beneath it was a mass that was well circumscribed, quite tender and not movable. There was no evidence of a pancreatic fistula.

Fig. 2. Semilateral view of stomach which shows a smooth type of defect involving the pyloric antrum.

The report of the roentgen examination at this time was as follows: "A plain film of the abdomen shows a mass in its upper mid-portion. On fluoroscopic examination the pyloric end of the stomach is fixed and shows an annular gross defect which involves the stomach from the pylorus upward for about 8 cm. The defect is smooth in outline and gives the impression that the stomach is being tightly grasped by an extragastric tumor. No gastric lumen could be demonstrated in this area except by turning the patient toward the left and forcibly driving the meal through the pyloric antrum. There is about a 60 per cent gastric retention after six hours and a small retention after twenty-four hours. Believe she has either an extragastric tumor, probably a pancreatic cyst, but the marked retention, the pyloric fixation and the very small gastric lumen may mean that the wall of the stomach itself is involved."

Operation was performed on October 10, 1931, by Dr. J. Shelton Horsley of Richmond. On entering the peritoneal cavity a bluish walled cyst was encountered. This was opened, and the contents were removed with a suction apparatus. The cyst contained about a quart of clear, slightly viscid material. It was apparently not infected. The cyst wall was made up of parietal peritoneum and of part of the transverse colon and the transverse mesocolon.

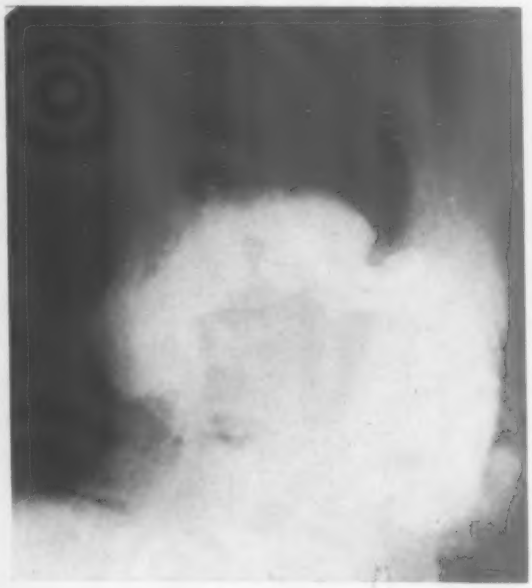

Fig. 3. Lateral view showing a change in the type of defect and a small lumen.

Fig. 4. Six-hour film showing definite retention.

It had infiltrated the posterior wall of the stomach, separating the muscular from the submucous coat. This infiltration was extensive, involving all of the posterior wall of the stomach and the injury to the pancreas was behind the stomach. It seemed best therefore to excise the stomach, as probably there had been too much damage to its wall to permit recovery. The gallbladder was adherent at one point, and the adhesions were separated. The gallbladder was not removed, as it contained no stones and it was thought that the adhesions were due to the inflammation of the pancreas and stomach. The specimen showed that the posterior wall of the stomach had been infiltrated and constituted a part of the wall of the pancreatic cyst. This appeared to have begun at the lesser curvature and infiltrated within the stomach wall, separating the muscular coat from the mucosa and appearing at the lower border of the stomach where it penetrated the muscle and a temporary cyst wall was formed and became adherent to the anterior abdominal wall. The gastric mucosa was congested and showed numerous points of erosion but there was no definite ulceration.

COMMENT

The case reported not only presents many of the usual findings of a pancreatic cyst but also some unusual ones.

From the roentgenologist's viewpoint, the defect in the pyloric end of the stomach, with both six and twenty-four hour retention was somewhat suggestive of malignancy. However, the smooth type of defect and the fact that it could be slightly changed by altering the position of the stomach seemed to justify a diagnosis of a non-malignant lesion.

At operation it was shown that the defect was due to a pancreatic cyst which had infiltrated into the wall of the stomach beginning at the lesser curvature, involving the posterior wall, and perforating at the lower border of the stomach. The infiltration was so marked that permanent recovery did not seem possible, making a resection necessary.

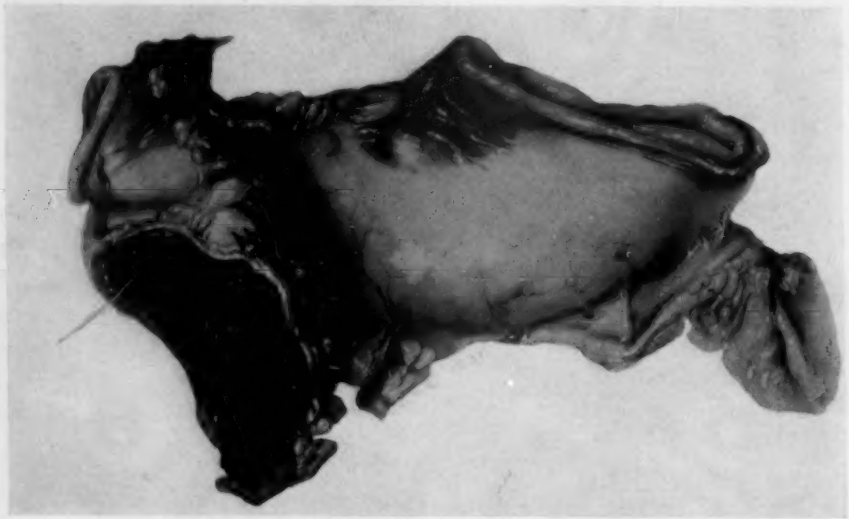

Fig. 5. Anterior view of drawing of specimen removed at operation showing where the cyst penetrated the muscle of the stomach.

Fig. 6. Posterior view of drawing of specimen showing that the infiltration began at the lesser curvature.

A survey of the available literature does not reveal a case where there was obstruction at the pylorus due to a pancreatic cyst within the wall of the stomach.

It seems probable that at the time of the accident some damage was done to the stomach as well as to the pancreas and that as the pancreatic fluid infiltrated the injured area of the wall of the stomach it dissected the muscular coats from the mucosa, forming a tumor within the gastric wall. This mass projected into the lumen of the stomach causing a large defect in the gastric contour and partial obstruction.

REFERENCES

1. Bird, C. E. Tumors which may expand the curvature of the duodenum, particularly tumors and infections of the retroperitoneal lymph nodes. *Ann. Surg.*, 1929, *89*, 12–29.
2. Brown, Samuel. Differential diagnosis of abdominal tumors by the roentgenological method. *Radiology*, 1928, *10*, 48–56.
3. Furrer, E. Ein Fall von Pylorusstenose infolge Pankreaszyste. *Schweiz. med. Wchnschr.*, 1931, *61*, 162–163.
4. Hulke. Pancreatic cyst. *Lancet*, 1892, *2*, 1273.
5. Judd, E. S. Mattson, H., and Mahorner, H. R. Pancreatic cysts; report of forty-seven cases. *Arch. Surg.*, 1931, *22*, 838–849.
6. Körte, Werner. Die chirurgischen Krankheiten und die Verletzungen des Pankreas· F. Enke, Stuttgart, 1898.
7. Lazarus, Paul. Beitrag zur Pathologie und Therapie der Pankreaserkrankungen mit besonderer Berücksichtigung der Cysten und Steine. *Ztschr. f. klin. Med.*, 1903, *51*, 95; 203; 1904, *52*, 146; 381.
8. Mahorner, H. R., and Mattson, H. The etiology and pathology of cysts of the pancreas. *Arch. Surg.*, 1931, *22*, 1018–1033.
9. Martin, A. Ein Fall von Pancreascyste. *Virchow's Arch. f. path. Anat.*, 1890, *120*, 230–247.
10. McWhorter, G. L. Cysts of the pancreas. *Arch. Surg.*, 1925, *11*, 619–632.
11. Warnock, H. A. Pseudocyst of the pancreas. *Brit. M. J.*, 1929, *1*, 104.

THE THERAPY OF ACTINOMYCOSIS

WITH CASE SHOWING LUMBAR SPINE INVOLVEMENT*

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THE subject of actinomycosis has been brought rather forcibly to our attention by the presence at one time of three cases in our wards, one of these having involvement of the lumbar vertebrae as a presenting symptom. There is apparently a paucity of literature dealing with the roentgenological aspects of this infection, particularly in regard to therapy.

Actinomycosis in the human is much more common than would be apparent from perusing the literature and is more widespread in distribution than is generally believed. Sanford and Voelker in 1925 made an extensive tabulation of all reported cases occurring in the United States. Their compilation shows that, although this disease is distributed widely in this country, it is especially prevalent in the upper Mississippi Valley and in the northwest portion of the country.

It is not in the province of this communication to discuss the pathology of human actinomycosis, as many publications have given adequate descriptions. It will perhaps be sufficient to enumerate the most usual sites of involvement in order of frequency as tabulated by Sanford and Voelker. According to their study, nearly 60 per cent of the cases occurred in the head and neck; slightly more than 18 per cent were abdominal; and the thoracic type was found in almost 14 per cent of the cases. However, more rarely, almost any portion of the body may be involved.

The mode of infection determines in large part the anatomical location of this disease. According to Mattson, the portals of entry in order of frequency are: first, oral cavity; second, gastrointestinal tract; third, respiratory tract; fourth, skin abrasions. Infection through the oral cavity usually occurs as a result of chewing straw, weeds, or grain, and is responsible for the frequent involvement of the mouth and jaws. Infection through the gastrointestinal tract occurs in much the same manner, except that the infected material is ingested and is responsible for the usual abdominal involvement of cecum and appendix. Infection through the respiratory tract is usually considered to be the result of inhalation of infected material, such as the dust and chaff found around threshing machines and hay baling presses. Infection through the skin by direct inoculation through open wounds or sores is responsible for most cutaneous lesions. Some of the skin manifestations are results of blood-borne infection, according to Good. Bone involvement is thought to be uniformly the result of direct extension and metastases and is never primary. The usual sites of bone involvement are mandible, ribs, pelvis, sternum, and vertebrae. Occasionally other bones may be affected. The lumbar vertebrae are rarely involved, although this involvement constitutes the presenting symptom in one of the cases reported in this communication.

The presenting symptoms of actinomycosis naturally vary with the anatomical location. In cervicofacial involvement, the most prominent feature is a hard, indurated swelling of the affected region, which, when adjacent to the mandible, causes impaired function. In the later stages, there is apt to be a breaking down of the induration with sinus tract formation.

Abdominal actinomycosis is rarely, if ever, correctly diagnosed at the initial examination. The presenting symptoms are indistinguishable from either acute or chronic appendicitis, and the patients are

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operated upon under these diagnoses. Even at operation, actinomycosis of the appendix is usually not differentiated from the usual forms of appendicitis and appendicial abscess, since the gross pathology is so similar. Usually only the clinical course following operation leads to the correct diagnosis. According to Good, the postoperative course is somewhat as follows: The convalescence is essentially that of the usual case of appendicitis, with good wound healing in a high percentage of cases. Several weeks after operation, there is an exacerbation of symptoms with toxic manifestations and tenderness either in the region of the incision or in the flank. By this time, an abscess has formed, which is usually incised and drained. A sinus tract then forms, which drains for an indefinite period. The chronically draining appendicial sinus should then lead the surgeon to rule out actinomycosis, for this is the most frequent cause of such sinuses. Repeated microscopic examinations of the material from the sinuses may be necessary before the fungus is found.

The symptoms of intrathoracic actinomycosis, according to Good, may simulate those of several other diseases: first, simple catarrhal or mucous bronchitis, when the sputum is mucoid, or bronchiectasis when the sputum is fetid; second, bronchopneumonia; third, tuberculosis; fourth, lung abscess. Roentgen examination of these cases shows no definitely pathognomonic features. Kirklin and Hefke have reviewed a series of 14 cases in which the roentgenological features are described, and they state that there is only one materially helpful diagnostic point when present, and that is rib destruction with apparent lung abscess. Chronic lung abscess would not lead to such involvement.

Actinomycotic lesions of the skin, according to Andrews, are rather characteristic, being local, dusky red swellings, deep, fluctuating nodules, and sinuses exuding a purulent discharge. This author states that primary actinomycosis of the skin is a rare disease.

The positive diagnosis of actinomycosis in the various locations depends upon the identification of the fungus microscopically. According to Figi and Cutts, actinomycosis must be considered as a diagnostic possibility with regard to indeterminate tumor, chronic infection, or persistent sinus, even if the patient is young. Any atypical chronic lung infection, any hard indurated swelling in the cervicofacial region, and particularly, any chronically draining abdominal sinus should at least arouse suspicion as to the possibility of actinomycosis. In all such cases, smears should be made from sputum and pus in an attempt to identify the fungus. Repeated examinations may be necessary before the organism is found. Tissue sections are sometimes of value, although negative reports do not exclude the possibility of the disease.

The treatment of actinomycosis has varied greatly from time to time. The original treatment was surgery alone, which gave rather unsatisfactory results. Later, iodides were administered internally either alone or in conjunction with surgery, and there was an improvement in results. According to Bérard, a commission appointed by the French Government in 1893 administered iodine experimentally to animals affected with actinomycosis. Out of 185 animals treated, 131 were reported as cured. Roentgen irradiation was successfully used by Harsha in 1904 in conjunction with incision and iodides by mouth. Since that time, numerous authors have presented their results, most of them ascribing the good results chiefly to irradiation. According to Desjardins, the clinical evidence of proved cases reported in the literature seems to indicate that the chief factor in these cases was irradiation, and not surgery and iodides. This author states that in his opinion neither surgery nor iodides are contraindicated but are distinctly useful in conjunction with irradiation. He also stresses the importance of early diagnosis so that treatment may be instituted before massive involvement has taken place. In our clinic, combinations of surgery and iodides with

roentgen irradiation have been used to advantage. Surgical intervention should be confined to the evacuation of pus. Massive doses of iodides are administered by mouth,

Fig. 1. Case 1. Showing invasion of lumbar vertebrae by actinomycosis.

the dosage varying with the size of the patient, but ranging up to 250 minims of potassium iodide three times per day. One child ten years of age, with cervicofacial involvement, received 160 minims thrice daily. With combined irradiation and iodide therapy, a cure was obtained. It has been our custom to administer a saturated solution of potassium iodide, giving 10 to 20 minims by mouth three times daily, and increasing the dosage quite gradually until the limit of tolerance is reached. More recently, we have been using tincture of iodine in milk, following the method of treatment outlined by Chitty in 1926. This author reports cures in four successive cases by the use of 5 to 10 minims of tincture of iodine, three times daily, freshly added to one-half cup of milk. According to Chitty, iodine in milk forms a truly colloidal solution, which might possibly be more effectual than the usual method of iodide administration, but our experience with this method is too recent and too limited to warrant any opinion regarding this form of therapy. These methods of iodide therapy are combined with roentgen irradiation. The voltage varies from 132 to 200 peak kilovolts, and the filtration varies from 4 mm. of aluminum in the relatively superficial to 0.5 mm. of copper plus 1 mm. of aluminum in the abdominal cases, each depending upon the location of the lesion. A sufficient number of portals is used to secure a depth dose equivalent to one-half erythema at the site of the lesion, the number of roentgens depending upon the quality of the radiation. This course of treatments is repeated every three weeks as long as there is indication, the location of the portals being varied to save the skin.

In our series of cases, there is one which has particularly interested us on account of the involvement of the lumbar vertebrae, which, judging from the cases reported in the literature, is quite rare. Briefly summarized, the case histories are as follows:

Case 1. Female, colored, aged fourteen, admitted to the Hospital complaining of an intermittently draining sinus in the right lower quadrant, present since an appendectomy three years previously. One year prior to admission, there was a mass which ruptured spontaneously over the anterior aspect of the left ilium. A second draining sinus persisted at this point. Six months prior to admission, the patient began to suffer with "stiffness in her right hip."

Physical examination on admission was negative except for two draining sinuses, 45° flexion of the right thigh, and extreme emaciation.

Roentgen examination (Figs. 1 and 2) of the pelvis and lumbar spine showed irregular,

fuzzy, new bone formation over the bodies of the lumbar vertebrae and the anterior aspect of the sacrum. In the bodies of the lumbar vertebrae, there were small, irregular areas of bone destruction. The intervertebral discs showed no narrowing. The peculiar appearance of the spine, together with the draining sinuses, led us to suspect actinomycosis, which was later proved microscopically.

The patient has received tincture of iodine in milk and roentgen irradiation since May 26, 1932, eight courses of 200 kv. radiation having been given. Her general condition at this time (September 10, 1932) shows little change, but there has been a distinct decrease in the amount of drainage from the sinus.

Case II. Female, colored, aged sixteen, admitted to the Hospital complaining of a "sore on her right side" of one month's duration.

Physical examination was essentially negative except for two draining sinuses on the right posterior axillary line at the level of the first lumbar vertebra, with a definite mass beneath the sinuses.

Roentgen examination of the chest was negative. An opaque enema showed a torsion deformity of the cecum without evidence of infiltration. Bilateral pyelograms showed a moderate degree of dilatation of the right renal pelvis and calyces.

The sinus tracts were explored surgically on several occasions and were seen to extend both to the right renal region and toward the cecum, but it was impossible to demonstrate definite primary involvement in either region. Smears were positive for actinomyces on several occasions.

The patient received massive doses of potassium iodide by mouth and sodium iodide intravenously, together with 200 kv. roentgen irradiation, keeping the lesion at one-half erythema dose level for a period of six weeks. The patient's condition steadily grew worse, and she died seven weeks after institution of therapy. Although strenuous efforts were made to obtain an autopsy, this was refused.

Case III. Male, white, aged fifty-one, farmer, was operated upon in November, 1928, for ruptured gangrenous appendix, following which a sinus tract developed. Some time after returning home, a hard mass developed to the left of the abdominal incision, which had continued to drain. In March, 1929, the patient was again admitted, presenting the mass and the draining sinus. An incision was made in the mass, and the sinus tract was opened up. Smears from the material removed were positive for actinomyces. Massive doses of potassium iodide were given in conjunction with 135 kv. roentgen irradiation, two courses being given. No improvement was noted. The patient did not return for further treatment and died about three months after institution of therapy.

Fig. 2. Case 1. Lateral view, showing normal joint spaces, fuzzy new bone formation, and small areas of bone destruction.

Case IV. Male, white, aged forty-seven, admitted to the Hospital April 1, 1928, one month after an acute illness. At the onset, the patient had a high temperature and chills for several days, with a pain in his right chest. On the day of admission, he coughed and expectorated large quantities of purulent material.

Physical examination revealed signs of right-

sided empyema. Laboratory studies revealed severe diabetes.

Roentgen examination showed encapsulated fluid in the posterior portion of the right thoracic cavity.

Thoracostomy was done, and 1000 c.c. of greenish yellow, purulent material was evacuated. A second drainage was done a month following this, soon after which actinomyces were discovered. About five months following this, swellings were noted over the angle of the left jaw and over the left scapula. Actinomyces were found in the material from these lesions.

Massive doses of iodides were started at this time, and roentgen irradiation was initiated two months following this. The patient received four courses of roentgen therapy and continuous iodide medication. He was discharged fourteen months after admission, considerably improved. He was able to resume part time work on the farm. Fifteen months following this, he was admitted for diabetic gangrene, his chest being in a quiescent stage. He was admitted twice within the next one or two years for control of the diabetes. In April, 1932, he was admitted for further treatment of the chest. In the seven months preceding this, the sinus tract in the lower right chest started draining continuously, having ceased draining three months after his first discharge from the Hospital. Since April, 1932, he has received six courses of roentgen irradiation with slight improvement.

Case v. Male, colored, aged nine, admitted to the Hospital complaining of swelling of the right jaw of six weeks' duration. This was associated with some pain and inability to open the mouth widely. There was some swelling in the right cervical region just below the angle of the jaw.

Roentgen examination showed well-defined new bone formation about the angle of the right jaw, without bone destruction.

Incision of the mass at this time showed only inflammatory tissue. Operation for drainage was done a month later and again a month following this, when an incision was also made over the cheek and the process found to extend up to the region of the frontal sinus. At this time, actinomyces were found.

The patient was put on massive doses of iodides by mouth and was given four courses of roentgen therapy. He was last seen six months after admission and was practically well. We have since heard that he is entirely well.

Case vi. Male, white, aged ten, admitted to the Hospital complaining of inability to open the mouth for the past four weeks. There was a definite hard mass at the angle of the left jaw, which was apparently fixed to the bone.

Roentgen examination was negative.

Incision into the mass was done with the evacuation of some pus which contained sulphur granules. The microscopic examination confirmed the diagnosis of actinomycosis.

The patient was started on massive doses of iodide by mouth, and roentgen therapy.

When the patient returned one month later, an inflammatory mass was excised. He was continued on iodide by mouth and given five courses of roentgen therapy. The patient was last seen December, 1930, four months after the first admission, and was much improved. We have since learned that this patient is entirely well.

Case vii. Female, white, aged twelve, admitted to the Hospital complaining of a swelling over the lower left jaw of six months' duration.

Roentgen examination showed some new bone formation about the angle of the mandible, with irregular areas of bone destruction.

Incision with evacuation of pus was done along with curettage of the bone. Sulphur granules were found, and these showed actinomyces microscopically. The operative wound healed nicely, and the patient left the Hospital in eight days. The patient was last seen in 1930, ten years after operation, and has had no recurrence of her trouble. Neither iodides nor roentgen therapy was used in this case.

Case viii. Male, white, aged forty-one, admitted to the Hospital complaining of inability to open the mouth, except partially, for six months previous to admission. There was a definite mass at the angle of the left jaw. Incision was made into the mass, and sulphur granules were found, which revealed organisms of actinomycosis on microscopic examination.

The patient was put on iodides by mouth, with the dose to be increased to 200 minims, three times daily. She was readmitted one month later, when another fluctuating mass was incised and drained, with curettage of the mandible. Iodides by mouth were continued for several weeks. The patient was apparently well within a few months, and when seen recently, eight years after operation, was entirely well.

COMMENT

From a study of the literature and observation of our limited series of cases, it is apparent that the response to therapy directed against actinomycosis varies greatly with the anatomical location. Cervicofacial involvement almost invariably responds well to surgical curettage, iodides, and roentgen irradiation, and frequently even to surgery alone, where the disease is well localized, as is shown in one of our cases. Where there is more extensive involvement, iodides and radiation therapy should be used as adjuncts to surgery, since complete surgical extirpation of the diseased tissues would be impossible on account of the complex cervicofacial anatomy and facial disfigurement. The cases of actinomycosis with thoracic and abdominal involvement present quite a different problem. Surgery in these cases plays a minor rôle and should be used only to evacuate pus and to establish drainage. Massive doses of iodides and roentgen irradiation are the principal therapeutic agencies in such cases. The results in these patients are not brilliant, but sufficient improvement has been noted to warrant the continuation of this method of treatment until the advent of a more satisfactory therapeutic regimen. Since thoracic and abdominal cases are usually not diagnosed until there is extensive involvement, it is apparent that one cannot hope for complete surgical removal of all of the diseased tissue. This being true, too radical surgery with dissection of all sinus tracts would tend to spread the process rather than to effect a cure. The best results in this type of case seem to be obtained by keeping these patients continuously on iodides by mouth up to the limit of tolerance, combined with roentgen irradiation, and by using surgery only for the evacuation of collections of pus.

SUMMARY

A case of lumbar spine involvement secondary to abdominal actinomycosis is presented.

Cervicofacial lesions usually respond readily to surgery, massive doses of iodides by mouth, and roentgen irradiation.

Thoracic and abdominal lesions are much less amenable to any form of treatment, but many are benefited to a greater or less degree by continuous massive doses of iodides up to the limit of tolerance, combined with roentgen irradiation. In these cases, surgery should be used only to establish drainage for collections of pus.

REFERENCES

1. Abbott, D. P. Primary actinomycosis of kidney. *J. Am. M. Ass.*, 1924, *82*, 1414–1415.
2. Albert, Henry, Hardy, J. B., and Harrison, J. W. Actinomycosis of the abdominal wall. *J. Am. M. Ass.*, 1923, *81*, 653–654.
3. Andrews, George C. Diseases of the Skin. W. B. Saunders, Philadelphia, 1930, p. 589.
4. Barlow, R. A. Actinomycosis of the tongue. *Ann. Surg.*, 1925, *81*, 881.
5. Bérard, D. G. The treatment of actinomycosis with potassium iodide. *Internat. Clin.*, 1921, *3*, 107–110.
6. Brickner, W. M. Pelvic actinomycosis; study of five consecutive cases successfully treated by operation. *Ann. Surg.*, 1925, *81*, 343–367.
7. Bruce, Herbert A. Actinomycosis. *Ann. Surg.*, 1923, *78*, 294–299.
8. Chitty, Hubert. Actinomycosis successfully treated by iodine in milk. *Brit. M. J.*, 1926, *1*, 418–419.
9. Desjardins, Arthur U. Radiotherapy in actinomycosis. *Radiology*, 1928, *11*, 321–332.
10. Figi, F. A., and Cutts, R. E. Actinomycosis in childhood. *Am. J. Dis. Child.*, 1931, *42*, 279–290.
11. Good, Louis P. Actinomycosis of the thorax. *Arch. Surg.*, 1930, *21*, 786–800.
12. Good, Louis P. Actinomycosis of the abdomen. *Arch. Surg.*, 1931, *22*, 307–313.
13. Harsha, William M. Actinomycosis of the jaw. *Ann. Surg.*, 1904, *39*, 459–460.
14. Heyerdahl, S. A. Actinomycosis treated with radium. *J. Am. M. Ass.*, 1919, *73*, 1928–1929.
15. Jensen, V. W., and Schery, C. W. Actinomycosis treated with methylene blue and roentgen ray. *J. Am. M. Ass.*, 1920, *75*, 1470–1473.
16. Mattson, W. W. Human actinomycosis, with special reference to source and mode of infection. *Surg., Gynec. & Obst.*, 1922, *34*, 482–494.

17. McWilliams, C. A. Actinomycosis of phalanx of finger. *Ann. Surg.*, 1917, *66*, 117–118.
18. Naussac, Joseph. Pathology, symptomatology and differential diagnosis of pulmonary actinomycosis. *Internat. Clin.*, 1921, *3*, 1–18.
19. New, G. B., and Figi, F. A. Actinomycosis of the head and neck. *Surg., Gynec. & Obst.*, 1923, *37*, 617–625.
20. Parker, C. A. Actinomycosis and blastomycosis of the spine. *J. Bone & Joint Surg.*, 1923, *5*, 759–777.
21. Sanford, A. H. Distribution of actinomycosis in the United States. *J. Am. M. Ass.*, 1923, *81*, 655–659.
22. Sanford, A. H., and Voelker, M. Actinomycosis in the United States. *Arch. Surg.*, 1925, *11*, 809–841.
23. Schugt, P. Actinomycotic parametritis. *Monatschr. f. Geburtsh. u. Gynäk.*, 1925, *69*, 192–201. Abs. in *J. Am. M. Ass.*, 1925, *85*, 157.
24. Simpson, W. M., and McIntosh, C. A. Actinomycosis of the vertebrae (actinomycotic Pott's disease). *Arch. Surg.*, 1927, *14*, 1166–1186.
25. Waterman, A. H., and Fitzpatrick, G. Cutaneous actinomycosis recurring after pregnancy. *Ann. Clin. Med.*, 1925, *3*, 697–705.
26. Weiser, A. Diagnosis of actinomycosis of the bladder. *Ztschr. f. urol. Chir.*, 1925, *18*, 211–217. Abs. in *J. Am. M. Ass.*, 1925, *85*, 1342.
27. Wohl, M. G. Fungous diseases of man in the State of Nebraska; sporotrichosis, blastomycosis, actinomycosis. *J. Am. M. Ass.*, 1923, *81*, 647–653.

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THE DETECTION AND ESTIMATION OF RADIUM IN LIVING PERSONS

IV. THE RETENTION OF SOLUBLE RADIUM SALTS ADMINISTERED INTRAVENOUSLY

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THE administration of soluble radium salts intravenously was undertaken in Elgin State Hospital in March, 1931, with a selected group of patients, classified for the most part as dementia praecox cases. Radium chloride in 10 microgram doses dissolved in isotonic sodium chloride solution, having a volume of 2 c.c., and carefully standardized, was injected at intervals of a few days to a week over periods which ranged from two months to six months. The lowest amount administered to any one patient was 70 micrograms, and the highest, 450 micrograms. During the last week in December the radioactivity of these patients was measured by both the gamma-ray method for testing persons for radioactivity and the expired-air method. In June, 1932, six months later, another series of tests for radioactivity was made on the same patients, no radium having been administered to the patients between the first and second measurements of radioactivity. The results of the radioactive measurements thus constitute a contribution to our knowledge of the retention of radium in the human body. In addition, a summary of clinical observations has been incorporated.

Recently Barker and Schlundt,[1] with the cooperation of a small group of medical men who have administered radium internally for several years, measured the radium retained by 10 patients to whom radium chloride had been administered orally and intravenously over periods ranging from two years to four years, and in amounts totalling from 80 micrograms to 1,455 micrograms. They also refer to earlier investigations on the elimination of radium given internally. In 5 of the patients the tests for radioactivity were negative, but one of the subjects retained between 20 to 30 micrograms out of 890 administered, one and two-thirds years after the last time radium chloride was administered intravenously. Through the courtesy of Mr. H. M. Armstrong of the Radium Extension Service we were given the opportunity of testing again one of the radioactive patients, Case IX, at this time, when fully two years had passed since radium had been administered. In 1930, the radium retained by this patient was found to be between 10 to 18 micrograms, and to our surprise this patient still retains nearly the same amount today. This anomalous result stands out in contrast to the findings upon second measurement of the patients in Elgin, each of whom shows a marked loss in radium during the lapse of six months.

EXPERIMENTAL PART

To determine the total amount of radium in the body it is necessary to make two sets of measurements: (1) the gamma-ray activity of the subject, and (2) the quantity of radon (radium emanation) continuously expired by the patient. The sum of the two measurements gives the total radium present.[2]

The basis for this method is readily understood when one bears in mind that the total radium in the body is made up of two parts: (1) the fraction which holds its offspring, radon and its transformation products, Ra A, B, and C, and (2) the part which continuously gives off the radon produced. The gamma rays from radium are emitted entirely by Ra C, whose amount depends solely upon that part of the radon produced and which is retained in the system. The radon which is exhaled by the patient does not contribute to the gamma-ray activity. By measuring the quantity of radon in the expired air, that part of the radium which escapes detection by the gamma-ray method is determined.

Gamma-Ray Measurements. The gamma-ray measurements were made with a new Wulf-Hess quartz-fiber (bifilar) instrument,[3] whose natural drift amounted to only one small subdivision of the scale of one of the fibers in 35 to 45 minutes. We followed very closely the method described by Schlundt, Barker and Flinn. The electrostatic capacity of the electrometer supplied by the makers is 1.04 cm., and a fall of one subdivision of one of the fibers represents a drop in potential of 3.44 volts for that part of the scale over which readings were always made. The extremely small natural ionization current of the instrument may be calculated by substituting values in the formula,

$$i = \frac{CV}{300\,t}$$

where i stands for the ionization current expressed in electrostatic units, which may be converted into amperes by dividing by 3×10^{9}; C is the electrostatic capacity, 1.04; V, the potential drop in volts, observed during the time, t, expressed in seconds; 300 being the factor for converting volts into electrostatic units. For a natural drift of one subdivision in 40 minutes, the value of i comes out 4.97×10^{-6} e.s.u., or 1.66×10^{-15} amperes. The number of ion pairs produced per second in the chamber of the electroscope is given by dividing the current, 4.97×10^{-6} e.s.u. by the unit charge, 4.77×10^{-10}, which gives about 10,000. Since the actual volume of the chamber of the electroscope is approximately 1000 c.c., it follows that the natural drift of the instrument corresponds to a production of 10 ions per c.c. per second.

Next suppose we observe the drift of the electroscope when a radioactive patient is sitting near it and we find that the fiber drifts one division in 25 minutes. Substituting for t in the above formula, and subtracting the natural ionization current, we find that the increase in drift corresponds to an ionization current of 2.98×10^{-6} e.s.u., or the production of 6.3 pairs of ions per c.c. per second by the penetrating radiation from the subject under test. This form of expressing activities has one advantage: activities measured with other electrometers similar in type but differing in capacity and voltage scale are directly comparable when expressed as ionization currents.

Useful as this method of expressing activities often is, it however falls short for one of our purposes, in not stating the actual quantity of radium present in the person under test. In computing the number of micrograms of radium responsible for the gamma-ray activity of the patients we divided the observed net drift per second by 0.000180 (180×10^{-6}). This calibration constant, 180×10^{-6}, for the Wulf-Hess instrument, used for making all the gamma-ray measurements, represents the net drift of each fiber in divisions per second produced by each microgram of radium present in the system.

This value for the calibration constant of our Wulf-Hess electrometer is based upon an experimental calibration of a duplicate instrument by Mr. F. L. Knowles of the U. S. Public Health Service.[4] He states:

"In order to determine the sensitivity of the Wulf-Hess electroscope under known and easily reproducible conditions (so that the readings obtained with this electroscope could be compared with those obtained with other electro-

scopes), a 10 mg. standard of radium enclosed in a cylinder of lead, having an outside diameter of 27 mm. and an inside diameter of 20 mm., was placed 65 cm. from the center of the electroscope, and the net rate of fall of the fibers of the Wulf-Hess electroscope determined under these conditions. It was found to be 0.331 divisions per second."

We placed a radium standard of 5.27 mg., 65 cm. from the center of our instrument and found the net drift to be 0.207 divisions per second. Our radium standard would produce a net drift in the electroscope calibrated by Knowles of 0.174 divisions per second. Hence, our instrument is a little more sensitive, the ratio being 1.19.

Since Knowles found that each microgram of radium in a human cadaver produced a net drift of 151×10^{-6} divisions per second in the Wulf-Hess electroscope used in his work, it follows that one microgram of radium will produce a net drift of $151 \times 10^{-6} \times 1.19$ or 180×10^{-6} divisions per second, and this is the value we have used in converting observed net drifts into micrograms of radium by the gamma-ray method of estimation.

Knowles determined the calibration constant of his instrument by measuring the net drift produced by the gamma radiation from a cadaver implanted with a number of radon seeds of known gamma-ray activity distributed over the body proportionately to the bone mass. An extended series of readings for three different amounts of radon averaged a net drift of 151×10^{-6} divisions per second per microgram of radium. Two other methods of calibrating gamma-ray electroscopes in terms of net drift per microgram of radium are described by Schlundt, Barker, and Flinn[2] and by Schlundt and Failla.[6]

The U. S. Public Health report gives still another convenient method of calibrating a gamma-ray electroscope:

"The distance from the electroscope at which an amount of radium equal to the amount of radium distributed in the body of the cadaver must be placed in order to produce the same net drift of the fiber, was determined by placing an arbitrary amount, 174.2 micrograms of radon at distances of 37, 36 and 34 cm. from the electroscope. The effective distance determined in this way was found to be 37.4 cm."

One thousand one hundred and twenty (1,120) micrograms of radium placed at a distance of 37.4 cm. from the center of our electroscope produced a net drift of 0.194 divisions per second, or the net drift per microgram of radium is 173×10^{-6} divisions per second.

Radon in Expired Air. The first series of determinations of the amount of radon in the expired air of the patients were made with two Lind electroscopes, the ionization chambers of which had a volume of 2,700 c.c. These instruments were loaned to us by Dr. Frederick B. Flinn of Columbia University. For the second series of measurements, the Lind electroscopes used were loaned to us by the U. S. Public Health Service. These electroscopes were used in preference to our own instruments on account of their low natural drift, which was generally less than 0.008 divisions per second and at times ran as low as 0.004 divisions per second.

Each electroscope was calibrated by us in terms of radium units. Readings of natural drifts were taken before and after each test, and always over the same part of the scale and over approximately the same number of divisions of the scale. With "expired air" in the chamber at least two sets of readings were always made, the first one ten minutes after the introduction of the exhaled air and then a second one after a noted interval of about half an hour. From these readings the maximum value was deduced by extrapolation on the ionization curve for radon. About once a day the extrapolated value was checked by making a set of readings at the time of maximum, three hours after introduction of the exhaled air. Thorium emanation was not detected in the expired air.

The expired-air tests were made by hav-

ing the subject blow through a drying train and an ionization chamber connected in series for a time, three to four minutes—sufficiently long to make sure that practically all the air originally in the chamber had been replaced by "expired air." Several patients could not be induced to blow normally and a few refused to blow at all. This accounts for question marks after a few values and for blanks in the table.

To calculate the quantity of radium that must be present to generate the radon that is continually being exhaled it is necessary, of course, to measure the volume of the air expired in normal breathing, in a given interval of time. This quantity was not measured for each patient. Instead, we have arbitrarily used the same factor for all patients. We have assumed an average value of one liter of air being expired in 8 seconds or 2.7 liters in 21.6 seconds. The first objective is to find the quantity of radon expired per second. This figure is obtained by multiplying the observed net drift of the electroscope by its calibration constant and dividing by 21.6. Then dividing by 2.09×10^{-6}, the rate at which radon is produced from radium, gives the number of grams of radium in the body producing the radon in the exhaled air.

Since the variations in the amounts of air exhaled by different persons over the same period of time are by no means small, it follows that the radium values reported for the expired-air determinations are only roughly approximate, and we must rely on averages in any discussion of these results.

We feel justified in assuming that the individual patient performed the blowing of air through the ionization chamber in practically the same way the second time he was tested as he did the first. The two radium values reported under expired air for the same patient thus appear to be quite comparable. Hence, the percentage decreases in radium values observed between the first and second series of tests do not involve the element of error that may exist in the actual number of micrograms of radium reported.

Measurements were made on one of the student nurses who had not received radium treatment. This control subject is the last one in the table.

The results of our measurements are summarized in Table 1. The second column gives the total quantity of radium administered to the patient expressed in micrograms. A dosage of 150 micrograms represents 15 treatments of 10 micrograms each administered weekly. In the third column is recorded the time that had elapsed between the last injection of radium and the date on which the first series of measurements for radioactivity were made, the closing week of December, 1931. The next column, four, gives the quantity of radium measured by the gamma-ray electrometer. This is the amount of radium from which the radon and its distintegration products are retained in the system. Column five gives the radium which produced the radon that is continually exhaled. The next column, six, gives the total radium retained by the patient; and the next column, seven, gives the percentage of radium still present in the system. In the second section of the table we have recorded in four columns the results of our second series of measurements made six months later.

Summary and Discussion. Of the 25 patients first measured, complete gamma-ray and expired-air tests were obtained for 13 in the second series of measurements. Omitting patient *N* from the first series, the 12 patients had received 2,190 micrograms of radium of which 93.6 micrograms were retained, or 4.3 per cent. Six months later, these 12 patients and patient *N* to whom a total of 2,550 micrograms of radium had been administered retained only 49.4 micrograms or 1.9 per cent. During the interval of nearly six months between the first and second series of measurements these patients eliminated 55 per cent of the radium present at the time of the first tests, or they lost radium at the rate of about 13 per cent per month as deduced by substituting in the simple exponential formula: $N = N_0 e^{-rt}$, where N is

45; N_0, 100; and t, 6 months; then, solving for r. The applications of this formula hold when we assume that the amount of radium eliminated at any time is proportional to the amount present at the time. The average percentage elimination of radium during the interval of six months between the first and second series of measurements is not changed materially by comparing separately instead of the totals, either the gamma-ray values or the expired-air values. The rate of elimination found adds to the findings of other investigators. They confirm one of the results of Seil, Viol, and Gordon[5] who studied the elimination of soluble radium salts and report that after the rapid elimination of radium during the first week after administration, they found the amount eliminated to be less than 1 per cent per day. Schlundt and Failla,[6] on the other hand, by analysis of excreta found that two dial painters who had contracted poisoning twelve years before, eliminated the radium at the rate of only 0.1 per cent per month. Evidently then, as time goes on, the radium remaining in the system becomes more firmly fixed.

At an early stage of our measurements we became impressed with the relatively high proportion of radon continually exhaled by the patients. The amount of radium which retains radon and its disintegration products, Ra A, Ra B, Ra C, was found to be less than one-seventh of the total present at the time the first series of measurements were made, and approximately one-sixth of the total present six months later. Adding up the gamma-ray values and expired-air values for 12 of the most radioactive dial painters free from meso-

TABLE I

RADIUM RETENTION OF PATIENTS

Patient	December, 1931						June, 1932			
	μgm. Ra Given	1st Interval	μgm. Ra Gamma Ray	μgm. Ra Expired Air	Total Ra	Ra Retained per cent	μgm. Ra Gamma Ray	μgm. Ra Expired Air	Total Ra μgm.	Ra Retained per cent
A	150	6 mo.	1.0	7.2	8.2	5.5	0.9	2.5	3.4	2.3
B	150	6	0.6	5.4	6.0	4.0	0.3	2.8	3.1	2.2
C	150	6	0.3	3.4	3.7	2.5	0.17	1.4	1.6	1.1
D	150	6	1.4	12.5	13.9	9.6	—	—	—	—
E	160	6	1.3	12.5	13.8	8.8	1.4	4.1	5.5	3.5
F	160	6	0.9	3.7	4.6	2.9	0.7	—	—	—
G	160	6	0.7	2.9	3.6	2.3	0.3	0.0	0.3	0.2
H	160	6	0.4	3.4	3.8	2.4	0.08	1.8	1.9	1.2
I	180	6	0.8	5.9	6.7	3.7	0.09	1.8	1.9	1.1
J	200	6	0.3	5.9	6.2	3.1	0.07	4.1	4.2	2.1
K	200	6	0.5	—	—	—	—	—	—	—
L	260	4	2.3	12.0	14.3	5.5	1.8	3.3	5.1	2.1
M	380	4	1.0	—	—	—	1.3	—	—	—
N	360	6	1.1	1.8?	2.9?	—	0.9	5.7	6.6	1.8
O	260	23 d.	1.2	6.4	7.6	2.9	0.7	2.4	3.1	1.2
P	250	30	1.1	5.8	6.9	2.8	0.9	4.2	5.1	2.2
Q	450	20	1.6	16.1	17.7	4.0	1.3	—	—	—
R	410	13	1.1	—	—	—	—	—	—	—
S	70	60	0.5	—	—	—	—	—	—	—
T	110	30	0.75	8.3	9.0	8.2	0.5	4.8	5.3	4.9
U	90	30	0.5	—	—	—	0.6	—	—	—
V	100	30	0.3	6.2	6.5	6.5	—	—	—	—
W	90	30	1.1	8.6	9.7	10.8	—	—	—	—
X	90	30	0.3	3.9	4.2	4.7	—	—	—	—
Y	—	—	0.03	.00	0.03	—	0.01	.00	—	—

thorium, measured by Knowles of the U. S. Public Health Service, we find that the radon exhaled falls slightly short of one-half of the total produced by the radium present in the subjects. Likewise, the percentage of radon expired by radioactive patients measured by Barker and Schlundt falls slightly below half of the total.

The high emanating power of the radium present in the Elgin patients indicates that the radium had not yet passed into the crystalline state of aggregation.[7] Although the solubility of radium sulphate is fully 100 times less than that of barium sulphate, the volume of the blood can carry in solution a quantity five times the doses (10 μgm.) regularly administered to the Elgin patients. Probably then the radium ions exist in the system in combination with colloidal substances analogous to radium adsorbed on precipitated ferric hydroxide, which is characterized by its high emanating power.[8,9] This result of our investigation deserves further study.

As a consequence of the high emanating condition of the radium, its alpha radiation, the active therapeutic agent of radium present in the system, is diminished to about 40 per cent of the number of alpha particles which would radiate tissue if all the radon generated were retained. The gamma-ray values of the patients serve as an index of the penetrating radiations, the beta and gamma rays, whose source is mainly Ra C.

CLINICAL DATA

Before viewing the clinical aspect of the 32 psychiatric patients who were treated at the Elgin State Hospital from March to December, 1931, with intravenous injections of radium chloride, the following points should be clearly understood.

Previous researches on the rate, manner, and completeness of the elimination of radium from the body convinced us of the harmlessness of our dosages. We therefore were certain not to injure the health of the patients.

We used only a reliably standardized solution of radium chloride, thus avoiding the hazards which are inherent in uncontrolled products. This safeguard was also necessary in view of the fact that unfavorable comments have accompanied the application of many commercial radium products.

The biologic action depends on the degree of ionization which in turn is directly proportional to the quantity of alpha radiation. The penetrating range of alpha rays is exceedingly short compared with gamma rays, and the maximum exploitation, therefore, is assured if the source of alpha rays—in this case, the pure radium salt—comes in the closest possible contact with all tissues of the body. For that reason, the injections were given intravenously.

Radium and its derivatives have been used by many investigators; some reports are enthusiastic, some dispute its value. More or less convincing claims have been advanced that it stimulates hematopoiesis, metabolism, excretion of nitrogen in the urine and mobilization of sulphur; that it acts in a way similar to arsenic as a general tonic; that it combats toxemias by increasing oxidation, lessens the coagulation time of the blood and intensifies the glandular activity. If these claims are anywhere near the truth, radioactivity in the living body might result in some benefit in certain psychoses.

Beyond a large vocabulary and an imposing array of speculations about "mental mechanisms," we know very little about the causation of a large number of mental disorders. But just because our crude pathological anatomical methods fail to reveal gross alterations in the structure of the brain, we could hardly assert that there can be no molecular or atomic alteration of the brain structure. Dissociation, ionization, hydration, dehydration, etc.,—who knows much about the rôle they play in the living nerve cell? We admit that in using radium as an alterator of molecular structure, for instance, or as a source of radiating energy in general, we have a vague idea that it

TABLE II
AMOUNT OF TREATMENT AND IMPROVEMENT*

Patient	Psychiatric Classification	Amount of Treatment	Improvement
Evangeline P.	D. P. Paranoid	140 μgm.	2-plus
(E) Elizabeth J.	Invol. Melancholia	160	2-plus
(M) Anna M.	D. P. Paranoid	360	3-plus (At home)
(S) Lina P.	Invol. Melancholia	70	3-plus (At home)
(V) Lawrence P.	D. P. Catatonic	100	3-plus (At home)
(T) Dorothy D.	D. P. Hebephrenic	110	3-plus (At home)
(U) Allan W.	D. P. Hebephrenic	90	4-plus (At home)
(W) Charles W.	D. P. Unspecified	90	4-plus (At home)
Rose D.	Manic. Dep., Dep.	200	4-plus (At home)
Edith C.	Undiagnosed Psych.	260	4-plus (At home)
Sadie S.	Invol. Melancholia	150	4-plus (At home)

Total number of improvements and recoveries, 11

(In the above table 2-plus signifies moderate improvement, 3-plus considerable improvement, and 4-plus recovery.)

* The capital letters are the patients listed in Table 1.

must in some way affect living matter. These considerations, together with the initiative of Dr. F. D. John and Dr. A. J. Carlson, both ardent advocates of the internal use of radium, prompted us to try radium chloride injections in some of our cases to observe its clinical results and to measure the rate of elimination by accurate scientific measurements. Our study might serve as an inducement to others to make better and more intelligent observations. After all, not a few valuable achievements in medicine came into existence largely through empiricism or accident.

In this paper we are primarily concerned with the retention of radium in the human body after injection of a given quantity of radium. Hence, the clinical data are given only in a very abbreviated manner and as a sort of appendix. Thirty-two cases were treated with total doses ranging from 70 to 450 micrograms. Only 4 patients received less than 100 micrograms. Of this group, 8 were not available for subsequent measurements. However, since they were followed up by our social service department, they were evaluated from a psychiatric standpoint and are therefore included in the following summary:

PSYCHIATRIC CLASSIFICATIONS

Dementia Praecox		22
Hebephrenic type	8	
Catatonic type	9	
Paranoid type	4	
Unspecified type	1	
Involutional Melancholia		7
Manic Depressive, Depressed		2
Undiagnosed Psychosis		1
Total		32

(Of these there were 9 males and 23 females.)

RESULTS

Unchanged mental status:		
Dementia Praecox		16
Hebephrenic type	6	
Catatonic type	7	
Paranoid type	3	
Involutional Melancholia		4
Manic Depressive, Depressed, (Also tuberculosis)		1
Total		21
Improved mental status:		
Dementia Praecox		6
Hebephrenic type	2	
Catatonic type	2	
Paranoid type	1	
Unspecified type	1	
Involutional Melancholia		3
Manic Depressive, Depressed		1
Undiagnosed Psychosis		1
Total		11

This study was not undertaken to establish one more table of percentage of cures or improvements in cases of dementia praecox treated with radium chloride. Therapeutic claims based on such small groups as this one are advanced in the literature all too frequently. The endless variety of medicaments, coupled with widely contradictory reports of percentage results, bespeak their unreliability which in turn invites therapeutic nihilism.

Since there is room for difference of opinions regarding correctness of diagnosis and rate of spontaneous recovery in all such cases as reviewed above, the figures, of course, must be taken *cum grano salis*. Our results were not sufficiently convincing to advocate any superiority of radium chloride over other therapeutic procedures in psychiatric patients.

REFERENCES

1. Barker, H. H., and Schlundt, Herman. The detection, estimation and elimination of radium in living persons given radium chloride internally. II. Am. J. Roentgenol. & Rad. Therapy, 1930, *24*, 418–423.
2. Schlundt, Herman, Barker, H. H., and Flinn, F. B. The detection and estimation of radium and mesothorium in living persons. I. Am. J. Roentgenol. & Rad. Therapy, 1929, *21*, 345–354.
3. Hess, V. F. Ueber Neuerungen und Erfahrungen an den Radiummessungen nach der gammastrahlenmethode. *Phys. Z.*, 1913, *14*, 1135–1141.
4. Health Hazards of Radium Dial Painting, 1933, U. S. Public Health Service. (With permission of the authors, and courtesy of Dr. J. P. Leake.)
5. Seil, H. A., Viol, C. H., and Gordon, M. A. The elimination of soluble radium salts taken intravenously and per os. *Radium*, 1915, *5*, 40–44.
6. Schlundt, Herman, and Failla, G., The detection and estimation of radium in living persons, III. The normal elimination of radium. Am. J. Roentgenol. & Rad. Therapy, 1931, *26*, 265–271.
7. Lind, S. C., Underwood, J. S., and Whitemore, C. F. *J. Am. Chem. Soc.*, 1918, *40*, 465–472.
8. Hahn, O., and Heidenheim, J. Ueber Hochemanierende Radium-Präparate. *Ber.*, 1926, *59*, 284.
9. Kurbatow, Iw., Adsorption of thorium X by ferric hydroxide at different pH. *J. Phys. Chem.*, 1932, *36*, 1241–1247.

Vol. XXX, No. 4

THE PHYSICAL FOUNDATIONS OF CHEST ROENTGENOGRAPHY*

PART III. CONTRAST

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ROCHESTER, NEW YORK

THE term "contrast" may be applied in general to the differences in density occurring in the different areas of the roentgenogram. Adjacent areas must differ in brightness by about 2 per cent or more in order to be distinguishable and, of course, somewhat greater differences in brightness are more readily perceived. The greater the contrast in the roentgenogram, the finer are the differences in roentgen-ray absorption in the subject which become observable. Contrast *should not be made too high*, however, or some areas will be either so dark or so light that little or no detail can be seen in them.

It is a characteristic of photographic materials that they show poorer density differentiation in the lower densities than in intermediate densities. Within the range of densities useful in roentgenography, roentgen-ray film shows a continuous increase in density differentiation with increase of density. At the higher density values, however, the eye becomes increasingly less able to distinguish density differences existing in the film. Thus, the useful density range is restricted by the limitations of the photographic emulsion at the low end of the density scale, and by the limitation in ocular vision at the high end of the scale. Increasing the brightness of the illumination by which the roentgenograms are viewed will increase somewhat the useful density range, and the perception of density differences in the higher densities, but there are practical limits to this procedure also.

These considerations may be illustrated schematically by the diagram of Figure 1(*a*). Along the base line, intervals of equal intensity ratios are laid off; these intensities may be considered to have been incident on the roentgen film, and vary depending on the degree of absorption the roentgen rays have encountered in traversing different portions of the patient. The photographic blackening produced by each intensity, as judged by the eye in viewing the roentgenogram as a whole, is represented by the vertical height of the column above each intensity value. Thus, these blackenings, produced by the successive intensity values, form a series of steps which represent the density differentiation, or contrast, between successive blackenings of the film. At the lower end of the scale, these steps are small, but they increase in height as the blackenings become greater; this is due to a characteristic property of photographic emulsions. For the intermediate range of blackenings, the successive steps are about equal in height, showing a fairly uniform degree of contrast in this range. In the higher blackenings, the successive steps gradually diminish in height until a point is reached where no differentiation is visible; the steps appear to level off to a constant degree of blackening. This loss of contrast in the higher blackenings does not really exist in the roentgenogram, but is due to the inability of the eye to see it. For given conditions of illumination of the roentgenogram, the total useful range of blackening is fixed, by the maximum transparency of the film at one end of the scale, and by the maximum blackening through which the eye can see light at the other end of the scale.

Suppose that by some means the roentgenographic contrast is doubled, that is, the stepped differences in blackening are doubled in height. Assume also that the blackening corresponding to an intermediate intensity, say 8, in Figure 1(*a*), is

* Communication No. 503 from the Kodak Research Laboratories.

unchanged. Only the *differences* in blackening, and not general over-all blackening of the roentgenogram, are increased (Fig. 1(*b*). It is apparent that density differentiation, as represented by the heights of the steps, has been increased only in the intermediate blackenings, over the intensity range 4 to 16. Beyond this range, at both ends of the scale, density differentiation has diminished. At the extreme ends of the intensity scale, density differentiation which was visible with the lower contrast had disappeared completely at the higher contrast (steps 1, 1.4, 2, 32, 45.2, and 64.)

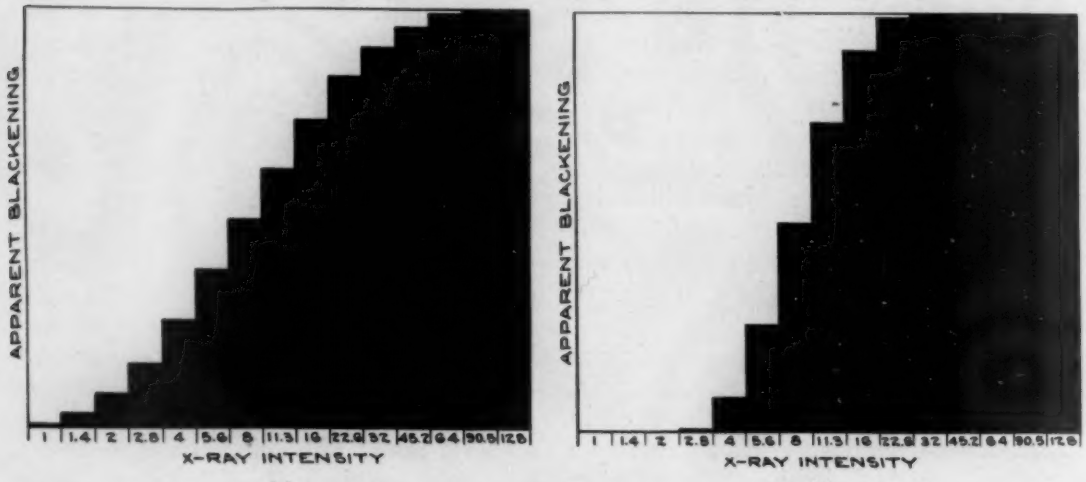

APPARENT BLACKENING
1 1.4 2 2.8 4 5.6 8 11.3 16 22.6 32 45.2 64 90.5 128
X-RAY INTENSITY
(a)
APPARENT BLACKENING
1 1.4 2 2.8 4 5.6 8 11.3 16 22.6 32 45.2 64 90.5 128
X-RAY INTENSITY
(b)

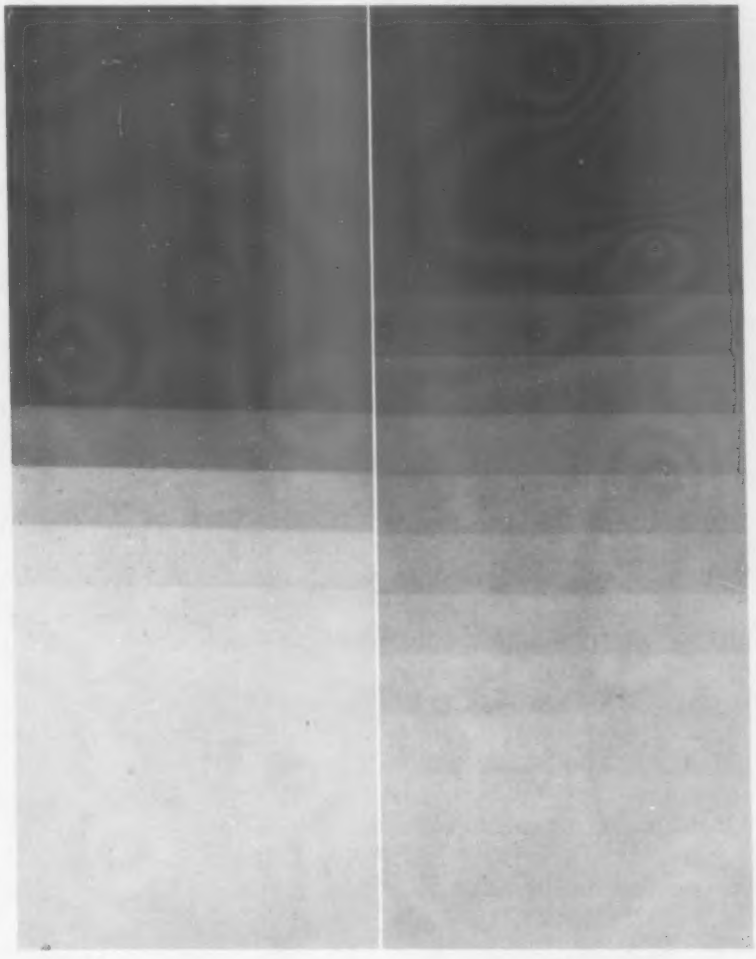
Fig. 1. Diagrams illustrating general relationship between the roentgen-ray intensity ratios incident upon the film and varying degrees of the resultant blackening as perceived by the eye, (*a*) for a roentgenogram of moderate contrast, and (*b*) for a roentgenogram of high contrast.

If the area of diagnostic interest is rendered entirely within the steps 4 to 16, then the higher contrast of Figure 1(*b*) is more suitable than that of Figure 1(*a*), but if it comprises blackenings outside the range, then the contrast of Figure 1(*b*) is excessive.

Let us assume that, for a given case, the area of diagnostic interest is rendered by the steps of blackening 4 to 16, so that the contrast indicated in Figure 1(*b*) is properly adapted to this roentgenogram. Suppose that a similar roentgenogram is exposed, but, by reason of error in exposure or development, the degree of blackening is greater than the optimum value. The highest blackening in the area of diagnostic interest will then have shifted into the region where contrast is diminishing, and some density differentiation will be lost. If the general blackening is less than the optimum value, the lowest useful blackening then drops into a region of lower contrast. If these same steps (4 to 16) are rendered by the lower contrast of Figure 1(*a*), the general degree of blackening can be raised or lowered somewhat without appreciable loss of density differentiation at either end of the scale. In other words, the lower contrast permits a greater latitude or variation from correct exposure and development.

These considerations show that some disadvantages, as well as advantages, are associated with high roentgenographic contrast. Contrast may not be increased safely beyond the point where essential detail is lost in either the higher or lower blackenings of the area of diagnostic interest, for the normal variations that occur in exposure and development. The more accurately correct exposure and development can be maintained, the higher may be the roentgenographic contrast.

These principles are illustrated photographically in Figure 2, which shows two roentgenograms of an aluminum step wedge exposed at tube voltages giving quite different degrees of contrast. In the roentgenogram made at the low voltage, the contrast in the intermediate blackenings is greater than in any portion of that made at high voltage. Associated with this higher contrast, however, is the fact that a smaller number of steps are visible than in the low voltage roentgenogram; a number of steps near the ends of the scale which show appreciable differentiation in the high voltage roentgenogram are lost completely in the low voltage roentgenogram. Thus, the low voltage roentgenogram exhibits a gain in contrast in the intermediate blackenings, accompanied by a loss, or even disappearance, of contrast in the higher and lower blackenings. The upper limit of roentgenographic contrast should be that which not only avoids loss of contrast in any portions of the area of diagnostic interest, but also allows sufficient leeway for the unavoidable



Low Kilovoltage High Kilovoltage

FIG. 2. Aluminum stepladder roentgenographed at two tube voltages. As tube voltage decreases, contrast in the intermediate steps increases, while the number of steps shown, and the density differentiation in the highest and lowest densities, both diminish.

variations in exposure and development.

At the present time, it is possible to point out only the general principles governing contrast, range of blackening, and latitude of exposure and development; much additional investigation will be required to make quantitative recommendations on these factors.

Roentgenographic contrast depends both upon the contrast characteristics of the roentgen film and upon the penetration of the rays making the exposure. In general, increased contrast of film is associated with a slower film speed, so that this method of increasing contrast requires an increase of exposure just as does the use of lower penetration secured by a lower tube voltage.

If higher contrast is secured by reducing tube voltage or by using a slower film, there is only one way in which the necessary increase in exposure can be produced without material sacrifice in other qualities of the chest roentgenogram, and that is by an increase in tube current. It has already been found that the exposure time should preferably not exceed 1/20 or 1/15 second, and to avoid excessive distortion, the target-film distance should be at least 4 feet. After reaching these limitations, the only legitimate additional compensation for the effect of a decrease in tube voltage is an increase in tube current.

There is some degree of interrelation between sharpness and contrast. The contrast between two adjacent densities appears greater if the dividing line is sharp than if this boundary is diffuse. On the other hand, the sharpness of such a dividing line appears to be improved by an increase in contrast between the two areas. Consequently, a change in technique which increases contrast and also diminishes sharpness may leave the resultant definition, and diagnostic value, about the same as before. If the loss in sharpness is small, and the gain in contrast fairly large, the result may be a net gain in effective definition. For instance, the use of the Potter-Bucky diaphragm necessitates an increased distance between patient and film; on a purely geometric basis, the sharpness should be poorer with the Potter-Bucky diaphragm than without it, and this loss of sharpness is frequently observable in roentgenograms made with the Potter-Bucky diaphragm. However, tests with a water phantom have shown that if the Potter-Bucky diaphragm is designed to make the distance between patient and film a minimum, the loss in geometric sharpness is small, and the improvement in contrast produced by the removal of scattered radiation is sufficient to overcome this deficiency and actually to improve the effective definition.[1]

SCATTERED RADIATION

The problem of scattered radiation has been given very little attention in chest roentgenography. The application of the Potter-Bucky diaphragm to chest roentgenography would introduce an additional complication, and it is desirable to ascertain first whether such a procedure would be worth while, at least as a routine method. It is possible to measure the relative proportions of scattered and direct radiation reaching the film in the roentgenography of any part of the body. Such measurements, applied to a group of chests of medium size, showed that, on the average, slightly over half the radiation reaching the film was scattered radiation. Less than half the radiation is employed in forming the roentgenographic image; the rest merely produces a general fogging effect. This scattered radiation not only reduces contrast, but also masks the effect of variation of voltage upon contrast, since the latter method changes contrast in only the direct, image-forming rays.

The proportion of scattered radiation is not uniform in all portions of the chest roentgenogram. In the group studied, the proportion of scattered radiation in the shadows of the apices averaged about 50 per cent. The proportion of scattered radiation was highest in the outer borders of the

[1] Wilsey, R. B. The efficiency of the Bucky-Diaphragm principle. AM. J. ROENTGENOL., 1922, 9, 58–67.

lung area, where the scattered radiation averaged 65 per cent, and the primary radiation 35 per cent, of the radiation rendering these areas on the film. Outside the apices and the outer border of the lungs, the proportion of scattered radiation was found to depend largely on tissue density, varying from about 40 per cent in areas where there were few lung markings, to about 60 per cent where the greater concentrations of lung tissue occur near the lower borders of the heart. Occasional observations showed proportions of scattered radiation as high as 75 per cent; these usually occurred near the borders of the lungs.

In large patients, particularly of the fleshy type, scattered radiation is undoubtedly a much more serious matter than in the case of patients of average size and build, such as were used to secure the above observations.

Scattered radiation diminishes both the contrast and the apparent sharpness of the image formed by the primary radiation. The attempts to increase contrast by a reduction in tube voltage, and to secure finer definition by use of a smaller focal spot, shorter exposure time, or synchronization of the exposure with the heart cycle are all obscured to a considerable degree by scattered radiation. In fact, the more that detail is beclouded by scattered radiation, the less is it affected by any change in tube voltage, size of focal spot, or exposure time. Logically any effort to improve the roentgenographic image should begin with a removal of scattered radiation; only after this is done can the methods which influence the primary radiation image be fully effective.

In the roentgenography of the thicker parts of the body, both experience and laboratory tests have shown that the use of the Potter-Bucky diaphragm increases contrast more than is possible by any practicable reduction in tube voltage. The Potter-Bucky diaphragm increases contrast most in those portions of the subject farthest from the film, producing a clarity of image impossible to secure in any other way. The proportion of scattered radiation occurring in chest roentgenography is less than that in the body parts with which the Potter-Bucky diaphragm is commonly used. However, tests with a water phantom, in which the proportion of scattered radiation reaching the film was similar to the higher values observed in chest roentgenography, showed that roentgenography with a Potter-Bucky diaphragm, at 100 kv.p. gave higher contrast and superior rendition of faint detail than could be obtained at 40 kv.p. without it. Furthermore, the energy of the exposure at 100 kv.p. with the Potter-Bucky diaphragm was considerably less than that required at 40 kv.p. without it.

Unquestionably, the areas of a chest roentgenogram which receive the higher proportions of scattered radiation can be improved more by removal of scattered radiation than by any feasible reduction in tube voltage; probably this is true also for areas receiving the smaller proportions of scattered radiation. Further experiments are in progress to test this point.

The application of the Potter-Bucky diaphragm to chest roentgenography will increase the exposure required by two to three times, other factors remaining the same. The use of the Potter-Bucky will also necessitate a new adjustment of tube voltage to secure the proper roentgenographic contrast; tube voltages would doubtless be somewhat higher than those commonly used at present, and this increase of voltage will partly compensate for the increase in exposure required with the Potter-Bucky diaphragm. The extent to which the energy of the exposure must be increased with the Potter-Bucky diaphragm and the consequent readjustment of focal spot size and exposure time will have to be determined after practical experience with the Potter-Bucky has indicated what tube voltage will give the most suitable contrast. Rather than increase tube current unduly, it would be preferable to reduce target-film distance to a minimum of 4 feet, since any choice of a distance

greater than this is of negligible importance compared to removal of scattered radiation.

It may be computed from the theory of Bouwers, as developed in Part II, that the increase in energy of the exposure made necessary by the Potter-Bucky diaphragm will cause a slight increase in unsharpness. The increased contrast, however, will doubtless more than compensate for this, and should provide a resultant definition superior to that obtained without the Potter-Bucky diaphragm.

SUMMARY

The general considerations governing roentgenographic contrast are outlined. As a rule, increasing contrast increases visibility of detail, but there are practical limits to the improvement obtainable by this method. Contrast should not be increased beyond the point where essential detail begins to be lost in the higher and lower blackenings of the roentgenogram; it is preferable to stop short of this limit in order to have sufficient latitude to allow for the unavoidable deviations from correct exposure and development.

In the average chest roentgenogram, scattered radiation forms more than half the radiation reaching the film; in some areas the proportion of scattered radiation commonly reaches 60 or 65 per cent. The adaptation of the Potter-Bucky diaphragm to chest roentgenography should, therefore, materially improve the contrast and clarity of the roentgenographic image.

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ENERGY CONSIDERATIONS IN MEDIUM AND HIGH VOLTAGE THERAPY

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ABSTRACT

Previous calculations[1] of the energy per roentgen are extended to the region where photo-electric absorption must be taken into account. A graph of calculated values covering the region from 20 to 1,000 kv. equivalent voltage is given.

The erythema dose is calculated on certain assumptions and plotted against equivalent voltage for the same range. This curve shows a distinct minimum at 80 kv.

The importance to the radiologist of the erythema dose is emphasized and it is pointed out that it must be determined with a large beam. It is shown that the total energy delivered when one erythema dose is given increases rapidly with voltage and with filtration. This increase together with the increase in depth dose is considered evidence for the superiority of hard radiation in deep therapy.

INTRODUCTION

IN A previous paper we have discussed the relation between energy of radiation and the roentgen for the region in which the photo-electric absorption can be neglected, i.e., above 100 kv. From these relations and the assumption that biological effects depend solely on the energy absorbed and are independent of wave lengths we calculated the number of roentgens which could be expected to produce an erythema of the skin and also the total energy delivered to the body when this dose was given. These calculations were made for monochromatic radiation, but it was suggested that for practical purposes radiation such as is used in deep therapy might be characterized by an equivalent wave length or equivalent voltage based on the half-value layer of water.

In the present paper we shall extend the same treatment to include the region in which the photo-electric absorption is important. Again the calculations apply to monochromatic radiation but it is much more doubtful if in this region the equivalent voltage as here defined is a very useful notion. It is also doubtful if any other simple definition would have much validity except possibly one based on the initial absorption in water. Nevertheless, the general trend of the several curves is instructive and it should be possible to test them at least qualitatively even for the lowest voltage used in deep therapy.

ENERGY PER ROENTGEN

In this case the energy absorbed in 1 cm.^{3} of air when E_0 ergs of radiation falls upon it is

$$E_a = ({}_e\sigma_a + {}_e\tau_{air}) E_0 n_a \qquad (1)$$

where ${}_e\sigma_a$ as before is the scattering absorption coefficient, ${}_e\tau_{air}$ the photo-electric absorption coefficient for air $n_a = 3.92 \times 10^{20}$ electrons per cm.^{3} of air. The energy required to produce one e.s.u. of charge in the form of ions is 0.107 ergs and we have therefore

$$E_0 = \frac{0.107}{n_a({}_e\sigma_a + {}_e\tau_{air})} \text{ ergs per cm.}^2 \text{ per roentgen} \qquad (2)$$

Siegbahn gives $\mu/\rho = 2.6$ in air for $\lambda = 1$ Å. From this we obtain ${}_e\tau_{air} = 79.1 \times 10^{-25}$ for $\lambda = 1$ Å and as ${}_e\tau_{air}$ is proportional to λ^3 we can calculate ${}_e\tau_{air}$ for all wave lengths shorter than the K limit of any element involved.

This enables us to evaluate equation (2). The result is shown graphically in Figure 1 which should be compared with Figure 4 in the previous paper. It will be noted that the curves are identical for high voltage but

[1] Lauritsen, C. C. Energy considerations in high voltage therapy. AM. J. ROENTGENOL. & RAD. THERAPY, September, 1933, 30, 380-387.

drastically different below 100 kv. as they obviously must be.

It is clear that the measurement of intensity at very low voltage is fraught with difficulty and a thorough understanding of the problem of absorption is essential to

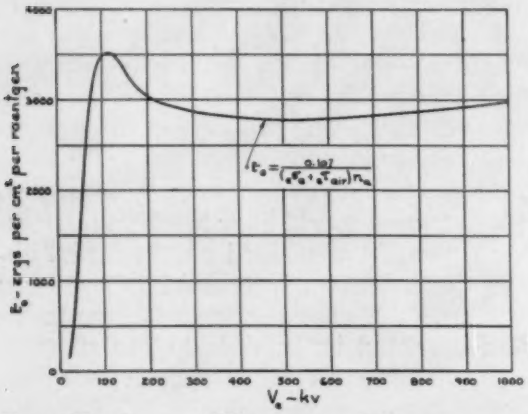

FIG. 1. Total energy falling on 1 cm.² when one roentgen is delivered. V_s = equivalent voltage.

the correct interpretation of the measurement. It is equally clear that if no biological wave-length dependence exists we can expect small, light biological samples in air to behave like air, i.e., a given number of roentgens should produce a certain effect on a given material regardless of wave length. The curve should therefore apply equally well in all such cases.

ABSORPTION IN WATER

If the material is less similar to air and if we use a wide beam then the beam is appreciably modified by the material, and the more the beam is modified the greater will be the variation in the number of roentgens required to produce a given effect. It should be noted that this is in no sense a biological wave-length dependence, but merely a result of the peculiarities of the roentgen unit, for when the intensity is correctly determined by means of an open air chamber, the ionization is due only to the so-called true absorption for which the coefficient per electron is ${}_e\sigma_a + {}_e\tau_{air}$, while in the case of a large body, say water, and a beam of large cross section there is an additional term due to the ultimate absorption of radiation which is scattered backward. If as before we let ${}_e\sigma_b$ be the coefficient for radiation scattered more than 90° we can write the absorption coefficient applying to a superficial layer of water in the form ${}_e\sigma_a + {}_e\sigma_b + {}_e\tau_{water}$, and we have for the energy E_s absorbed in this layer

$$E_s = ({}_e\sigma_a + {}_e\sigma_b + {}_e\tau_{water}) n_s E_0 R \text{ ergs per cm.}^2 \quad (3)$$

which gives

$$R = \frac{E_s}{({}_e\sigma_a + {}_e\sigma_b + {}_e\tau_{water}) n_s E_0} \quad (4)$$

and making use of equation (2)

$$R = \frac{E_s({}_e\sigma_a + {}_e\tau_{air})}{0.107({}_e\sigma_a + {}_e\sigma_b + {}_e\tau_{water})} \frac{n_a}{n_s} \quad (5)$$

We can calculate ${}_e\tau_{water}$ using the value $\mu/\rho = 3.8$ for water and $\lambda = 1$ Å (Siegbahn). The other coefficients are given in Figure 2 of the previous paper.

If we again consider the layer to be a surface layer of water 1 mm. thick and $E_s = 1.4 \times 10^4$ ergs, $n_s = 3.36 \times 10^{22}$ electrons per cm.² of this layer, we obtain the curve (Fig. 2) which should be compared with Figure 5 of the previous paper. The curves are identical at high voltage but quite different at low voltage.

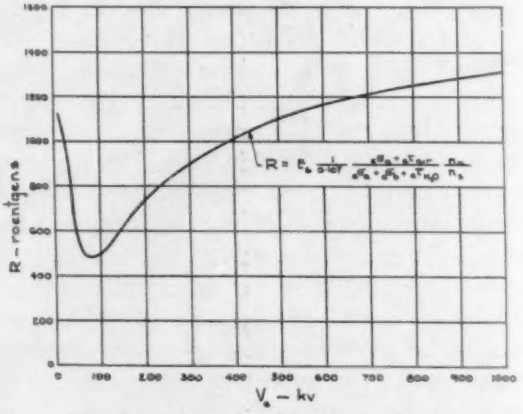

FIG. 2. Total number of roentgens required to cause absorption of 1.4×10^4 ergs per cm.² of a surface layer of water 1 mm. thick. This should be approximately equal to an erythema dose. V_s = equivalent voltage.

We are justified in expecting that if at any given wave length the number of roentgens indicated by the graph of Figure 2 is delivered to human skin using a large portal, it will in general produce an effect upon the skin which can be identified with some degree of erythema. If this is not so we must conclude either that the method of calculation here used is incorrect or that there is a biological wave-length dependence regarding the nature of which we are still in complete ignorance.

Our curve shows a distinct minimum for the number of roentgens required to produce an erythema. This minimum lies at about 80 kv. and the curve rises quite rapidly on both sides. In practice the minimum cannot be as sharp as the curve indicates for we are always dealing with a continuous spectrum which can be represented by an equivalent homogeneous beam only in first approximation. This will tend to make the minimum less sharp and distinct but it should be readily detectable experimentally. It is my understanding that this phenomenon is well known to radiologists who work with soft roentgen rays for superficial work.

The total energy delivered to a body when E_s ergs are absorbed in the surface layer is

$$E_0 = \frac{E_s}{({}_e\sigma_a + {}_e\sigma_b + {}_e\tau_{\text{water}})n_s} \text{ ergs per cm.}^2 \quad (6)$$

Using the same numerical values as above this expression gives us the graph shown in Figure 3, which should therefore be a reasonably reliable estimate of the total energy delivered to a body when one erythema dose is given.

It is perhaps well to call attention to the fact that although the equations here used should hold reasonably well for the cases here considered they cannot be expected to be applicable to the calculation of depth doses in this simple form. This is because of the gradual softening of the radiation with depth which is particularly marked with heavily filtered radiation.

DISCUSSION

The process of absorption of radiation is in general a very complicated one and we have seen in the foregoing that we must analyze it in some detail before we can make comparisons between various effects of radiation. To the best of our knowledge

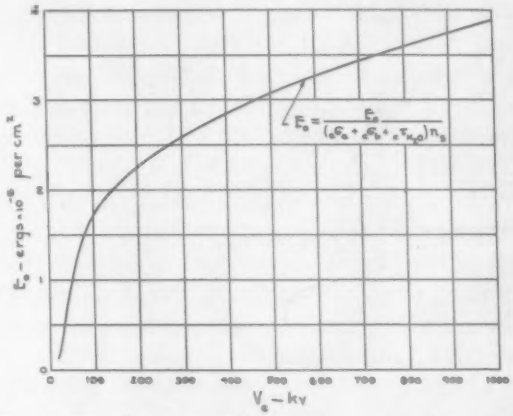

FIG. 3. Total energy delivered for 1.4×10^4 ergs absorbed per cm.^{2} of a surface layer of water 1 mm. thick. V_e = equivalent voltage.

there is so far no definite experimental evidence for a biological wave-length effect when we base the comparison on equal amounts of energy absorbed, but we cannot say that such an effect does not exist. What we can say is that if no such wave-length effect exists, then we should expect a given number of roentgens to produce a certain effect when and only when the mechanism of absorption is the same in the cases compared. Good examples are fly eggs or other light material suspended in air. In such experiments the absorption mechanism is almost identical with that for the open air chamber with which we determine the number of roentgens. It is therefore obvious that a given number of roentgens is equivalent to a given amount of energy absorbed and we should expect the same effect independent of wave length. It would be strange indeed if this were not so. On the other hand, the effect on a large body must, as we have shown in general, be very different, and we can therefore expect a great difference in the

erythema dose for different wave lengths except when an extremely small beam is used, say 1 cm. or less in diameter.

In practical therapy we are usually dealing with large bodies and large beams and it is clear therefore that neither the air chamber nor the fly eggs nor the skin effect of a small beam give the radiologist any useful information beyond telling him the number of roentgens delivered in a given time. In the treatment of cancer the radiologist has no guide other than the skin reaction and general clinical observations. Great as is the uncertainty and variation in the erythema dose its importance to the experienced radiologist can hardly be overestimated, for in most cases of deep-seated tumors the success or failure depends on the skin reaction, no matter what the wave length of the radiation is.

These are some of the reasons why radiology is still an art and probably will remain so for some time to come.

It should be clear from the foregoing that the best possible filter to use in connection with high voltage roentgen rays is that with the highest atomic number. Lead is very satisfactory. The thickness of filter used must of course be determined from practical considerations. The thicker the filter, the harder the radiation, but there is a limit to the sacrifice one can make in intensity.

The notion that an increase in the focal skin distance produces results similar to increased filtration or higher voltage is based on a misconception. This distance has no bearing on the energy delivered at a given depth except so far as it determines the size of port which must be used to cover a given region. The focal skin distance must therefore be determined solely from practical considerations in a given case.

Vol. XXX, No. 4

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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Thirty-fifth Annual Meeting: To be announced.

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Nineteenth Annual Meeting: Cleveland, Ohio, June 10-11, 1934.

EDITORIAL

THE AMERICAN CONGRESS OF RADIOLOGY

OLIVER WENDELL HOLMES once said: "Science is the topography of ignorance. From a few elevated points we triangulate vast spaces, enclosing infinite unknown details. We cast the lead, and draw up a little sand from abysses we shall never reach with our dredges."

In the great Hall of Science at the Century of Progress exposition in Chicago are displayed the grains and lumps of sand which constitute our knowledge of the basic sciences gleaned during the last hundred years. These bits of information gathered from the abysses are displayed in a unique fashion on the three great floors of the Hall, unfolding the stories of the discoveries of science and invention which have made the forces of Nature the servant of man and which are responsible for the incredible progress in the last century, of how science has added to the comfort and safety of man and is now used in his service and of the promises it offers for future benefits to man.

For the first time in an international exhibition are included the medical sciences demonstrating their dependence on the basic sciences in an effort to show the public that medicine is no longer veiled in mystery but is a science as well as an art and that those who practice it, to be successful, must be grounded in the basic sciences. Here are displayed the marvelous progress that the medical world has witnessed during the past hundred years which included such epoch-making episodes as the discovery and administration of ether, the great discoveries of Pasteur which opened up the whole field of bacteriology, as well as the epoch-making work of Koch in the discovery of the tubercle bacillus and the monumental work of Lister in the application of Pasteur's discoveries to the work-a-day world of medicine, and last but not least the epochal work of Faraday and the great group of scientists working in the realm of pure physics out of which ultimately came Roentgen's discovery of the x-ray.

When Roentgen, working in the realm of pure physics, cast the lead and brought forth the grain of knowledge which he designated the x-ray, he could not know that this weapon which has been added to the armamentarium of medicine would go far toward the elucidation of some of its most intricate problems. How could he know when the *Journal of the American Medical Association* in 1896 in commenting on the recent discovery of Roentgen had this to say, among other things: "The fact that we have . . . a force . . . that will act . . . through flesh, cartilage, skin, and other tissues of the animal body is enough to be fertile of practical suggestions to any thinking physician or surgeon . . . it hints of future valuable physiologic revelations as well as diagnostic aids. It is only a hint, however, and whether it is to be ever realized to any extent is perhaps open to serious question." In controversion of such a prophecy are exhibited some of the splendid achievements in medicine which the utilization of the roentgen ray and radium have brought forth, and not only the contributions which the roentgen ray has made in the field of pure medicine but also such fundamental discoveries as have been made in the application of the roentgen ray to physical and chemical problems, this agent contributing enormously to a newer conception of the finite structure of matter, so much so that a great field of knowledge in pure physics is as a result of these discoveries, about to be "plowed under" and a new "crop" of theories evolved as a substitute for some of the less tenable ones which have been built

up around the nucleus and the atom. All of the various basic sciences are grouped in such a manner as to dovetail into the whole scheme of the arrangement of the building, showing admirably the interrelation of the basic sciences with medicine.

Within the shadow of this great hall the first American Congress of Radiology held its meeting under the presidency of Dr. Henry K. Pancoast. The Congress consisted of the membership of the four roentgen and radium societies of the Americas, and the program which was so admirably arranged by Dr. G. E. Pfahler and his committee attested to the enormous progress that the roentgen ray and radium have made in the field of diagnostic and therapeutic medicine since their discovery in the last half of the last century.

There were certain by-products of the meeting which added a great amount of interest and not the least of these was the publication of the "Science of Radiology" edited by Dr. Otto Glasser. This source book prepared by special authorities represents an adequate and comprehensive presentation of the history and development of radiology, the American achievements in this field being given primary consideration, with much added mention of the contributions by radiologists, their clinical confrères, physicists, chemists and biologists from other nations. In addition a Portrait Catalogue of the members and associate members of the Congress was given to each member. The compilation of this Catalogue was a very happy thought on the part of those who had to do with the organization of the Congress as it gives a short but intimate medical biography of the various radiologists and physicists of the Americas.

All in all, the first American Congress of Radiology was a great success as evidenced by the quality and character of the program, the scientific exhibit, among which was an interesting display of old books dealing with the whole history of electricity from its beginning to the discovery of the roentgen ray, and a splendid exhibit of x-ray tubes, and the technical exhibits in which were shown all the latest developments in apparatus by the manufacturers of roentgen-ray equipment.

To the various local committees which had to do with the physical arrangements of the meeting as well as the scientific aspect of it are due great credit. As so often happens in meetings of this kind the burden of the work usually falls upon a few, and the various societies who participated in the Congress owe very great thanks to Dr. B. H. Orndoff who as chairman of the Executive Council worked untiringly to assure the success of the meeting.

The Congress was not only an exposition of the present accumulated knowledge and experience in the various fields of endeavor in radiology but it offered an opportunity for a combined expression of opinion of a large group as to the future aspirations and ideals of radiology as a specialty.

SOCIETY PROCEEDINGS CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

United States of America

American Roentgen Ray Society
Secretary, Dr. E. P. Pendergrass, University Hospital, Philadelphia, Pa.
Annual Meeting: 1934, to be announced.

American College of Radiology
Secretary, Dr. Albert Soiland, 1407 S. Hope St., Los Angeles, Calif.
Annual meeting: Cleveland, 1934.

Section on Radiology, American Medical Association
Secretary, Dr. J. T. Murphy, 421 Michigan St., Toledo, Ohio.
Annual meeting: Cleveland, Ohio, June 11–15, 1934.

Radiological Society of North America
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y.
Annual meeting: 1934, to be announced.

Radiological Section, Los Angeles County Medical Society
Secretary, Dr. R. T. Taylor, Los Angeles, Calif.
Meets on the third Wednesday of each month at the California Hospital.

Radiological Section, Southern Medical Association
Secretary, Dr. C. H. Heacock, 20 S. Dunlap St., Memphis, Tenn.
Annual meeting: Richmond, Va., November, 1933.

Brooklyn Roentgen Ray Society
Secretary, Dr. G. W. Cramp, 921 President St., Brooklyn, N. Y.
Meets monthly on first Tuesday, October to April.

Buffalo Radiological Society
Secretary-Treasurer, Dr. Joseph S. Gian-Franceschi, 610 Niagara St., Buffalo, N. Y.
Meets second Monday of each month except during summer months, place of meeting selected by the host.

Chicago Roentgen Society
Secretary, Dr. R. G. Willy, 1138 N. Leavitt.
Meets second Thursday of each month October to May inclusive at the Palmer House.

Cincinnati Radiological Society
Secretary, Dr. H. G. Reineke, Christian R. Holmes Hospital, Cincinnati, Ohio. Meetings held monthly.

Cleveland Radiological Society
Secretary, Dr. Otto Glasser, Cleveland Clinic.
Meetings are held at 6:30 P.M. at the Cleveland Chamber of Commerce Club rooms on the fourth Monday of each month from October to April, inclusive.

Detroit Roentgen Ray and Radium Society
Secretary, Dr. E. R. Witwer, Harper Hospital.
Meets monthly on first Thursday from October to May, at Wayne Country Medical Society Building.

Florida Radiological Society
Secretary, Dr. W. McL. Shaw, 418 St. James Bldg., Jacksonville, Fla.
Meetings held twice a year, May and November.

Illinois Radiological Society
Secretary, Dr. H. W. Grote, 219 N. Main St., Bloomington, Ill.
Regular meetings held quarterly.

Indiana Roentgen Society
Secretary, Dr. J. N. Collins, Indianapolis, Ind.
Annual meeting each February 22 in Indianapolis.

Michigan Association of Roentgenologists
Secretary, Dr. S. W. Donaldson, St. Joseph's Mercy Hospital, Ann Arbor, Mich. Three meetings a year, Fall, Winter, and Spring. Next meeting, Kalamazoo, Mich., October, 1933.

Milwaukee Roentgen Ray Society
Secretary, Dr. J. E. Habbe, 221 Wisconsin Ave., Milwaukee, Wis.
Meets first Friday in October, December, February and April. Place of meeting designated by the president.

Minnesota Radiological Society
Secretary, Dr. L. G. Rigler, University Hospital, Minneapolis, Minn.

New England Roentgen Ray Society
Secretary, Dr. Thomas R. Healy, 370 Marlboro St., Boston, Mass.
Meets monthly on third Friday, Boston Medical Library.

New York Roentgen Society
Secretary, Dr. C. W. Schwartz, 33 E. 68th St., New York.
Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

North Carolina Roentgen Ray Society
Secretary, Dr. Major Fleming, Rocky Mount, N.C.
Annual meeting at time and place of State Medical Society. Mid-year scientific meeting at place designated.

Central New York Roentgen Ray Society
Secretary, Dr. H. S. Bull, 604 Masonic Temple, Auburn, N. Y.
Three meetings a year—January, May and November.

Pacific Roentgen Club
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif.
Meets annually, during meeting of California Medical Association

Pennsylvania Radiological Society
Secretary, Dr. W. E. Reiley, Clearfield, Penna.

Philadelphia Roentgen Ray Society
Secretary, Dr. Karl Kornblum, Graduate Hospital.
Meeting first Thursday of each month from October to May inclusive, at 8:15 P.M., in Thompson Hall, College of Physicians, 19 S. 22d St.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. W. W. Fray, Strong Memorial Hospital.
Meets monthly on second Thursday from October to May, inclusive, at 7:45 at the Rochester Medical Association Building.

St. Louis Roentgen Club
Secretary, Dr. W. K. Mueller, University Club Bldg.
Meets first week of each month. Time and place of meetings designated by president.

South Carolina X-Ray Society
Secretary, Dr. R. B. Taft, 105 Rutledge Ave., Charleston.
Meets at time and place of South Carolina State Medical Association.

Texas Radiological Society
Secretary-Treasurer, Dr. C. P. Harris, Houston, Texas.

* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

Meets annually one day preceding the meeting of the Texas State Medical Association.

University of Michigan Roentgen Ray Society
Secretary, Dr. C. C. Taylor, University Hospital, Ann Arbor, Mich.
Meets first and third Wednesday evening of the month from October to June, at 8 o'clock in the amphitheatre of the University Hospital.

Virginia Roentgen Ray Club
Secretary, Dr. Wright Clarkson, 205 S. Sycamore St., Petersburg, Va.
Meets annually in October.

Cuba

Sociedad Cubana de Radiologia y Fisioterapia
Secretary, Dr. Luis Fariñas, Animas 110, Havana, Cuba.
Meets monthly in Havana.

British Empire

British Institute of Radiology Incorporated with the Röntgen Society
Meets on the third Thursday of each month, from November to June inclusive, at 8:15 P.M., at 32 Welbeck St., London, W. 1., or as advertised.

Electro-Therapeutic Section of the Royal Society of Medicine (Confined to Medical Members)
Meets on the third Friday of each month during the winter at 8:30 P.M. at the Royal Society of Medicine, 1 Wimpole St., London, W. 1.

Section of Radiology and Medical Electricity, Australasian Medical Congress
Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

Radiological Section of the Victorian Branch of the British Medical Association
Secretary, Dr. Colin Macdonald, Lister House, 61 Collins St., Melbourne, Australia.
Meets monthly at Melbourne during the winter.

Section on Radiology, Canadian Medical Association
Secretary, Dr. A. H. Rolph, 160 St. George St., Toronto, Ont.

Indian Radiological Association
Secretary, Sd. Subodh Mitra, 148 Russa Rd., Calcutta.
Meets annually in January, and at such places and times as the Council may appoint.

Radiological Section, New Zealand British Medical Association
Secretary, Dr. P. C. Fenwick, The Hospital, Christchurch. Meets annually.

Continental Europe

Belgian Society of Roentgenology
Secretary, Dr. J. Boine, Avenue des Allies, 134, Louvain, (Belgian).
Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summer time.

Société de Radiologie Médicale de France
Meets monthly on second Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

Société Suisse de Radiologie (Schweizerische Röntgen-Gesellschaft)
Secretary for French language, Dr. A. Grosjean, La Chaux de Fonds.
Secretary for German language, Dr. Scheurer, Molzgasse, Biel.
Meets annually in different cities.

Société Francaise d'Electrothérapie et de Radiologie Médicale
Meets monthly on fourth Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

Association of German Roentgenologists and Radiologists in Czecho-Slovakia
Secretary, Dr. Walter Altschul, German University, Prague, 11/52.

Deutsche Röntgen-Gesellschaft (Gesellschaft für Röntgenkunde und Strahlenforschung)
Meets annually in April in different German cities, at least once in five years in Berlin. Meets in addition every two years with the Gesellschaft deutscher Naturforscher und Aerzte.
Permanent secretary, Professor Dr. Haenisch, Klopstockstrasse 10, Hamburg, Germany.

Dutch Society of Electrology and Roentgenology
Holds two meetings a year in Amsterdam, one in the Spring, and one in the Fall.

Societa Italiana Radiologia Medica
Secretary, Professor M. Ponzio, University of Turin, Turin.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Oscar Meller, Str. Banul Maracine 30 Bucarest, Rumania.
Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad, USSR, in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson.
Meets annually.

Leningrad Roentgen Ray Society
Secretaries, Drs. S. G. Simonson and G. A. Gusterin.
Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

Moscow Roentgen Ray Society.
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky.
Meets monthly on the first Monday at 8 o'clock, the place of meeting being selected by the Society.

Polish Society of Radiology
Secretary, Dr. Jan. Kochanowski, 45 Gornoslazka St., Warsaw. Meets annually.

Warsaw Section, Polish Society of Radiology
Secretary, Dr. B. Krynski, 11 Zielna St.
Meets once a month except in the summer time.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies, with exception of the Denmark Society, meets every second month except in the summer time.

Society of Medical Radiology of Sweden
Meets in Stockholm.

Society of Medical Radiology in Norway
Meets in Oslo.

Society of Medical Radiology in Denmark
Secretary, Dr. H. Scheuermann, Copenhagen.
Meets on the second Wednesday of each month from October to July in Copenhagen, at 8 o'clock in the State Institute of Roentgenology.

Society of Medical Radiology in Finland
Meets in Helsingfors.

Vienna Society of Roentgenology
Meets first Tuesday each month, October to July.

Orient

Japan X-ray Association
c/o Orthopedic Surgery, Tokyo Imperial University.
Meets annually in April.

Kinki Roentgen-Abend Society
Director, Dr. Prof. Taiga Saito, Ogawaoike, Kyoto, Japan. Meets bi-monthly on third Sunday.

FOURTH INTERNATIONAL CONGRESS OF RADIOLOGY

The Fourth International Congress of Radiology will be held in Zurich, Switzerland, July 24–31, 1934, under the patronage of the President of the Confederation. The last days of the Congress and the closing session will be held in St. Moritz (Engadine).

Ordinary members of the Congress can be: (a) members of radiological societies of all countries; (b) persons recommended by such societies. Relations of the ordinary members who wish to take part in the entertainments may attend the Congress as associate members. The membership fee is: for ordinary members, 60.—Swiss Francs; for associate members, 30.—Swiss Francs.

Persons who wish to be registered as members should make application to the General Secretary, Gloriastrasse 14, Zurich, and send the membership fee to the "Schweizerische Kreditanstalt" in Zurich before January 1, 1934.

A list of members will be issued in the form of a portrait catalogue.

At the opening session representatives of the various countries will report on the organization of the cancer campaign in their country. These reports will be published in a special volume.

At the general meetings the following subjects will be taken up:

Roentgen Diagnosis of Bone Tumors.
Vasography.
The Development of Pulmonary Tuberculosis as Seen Roentgenologically.
Radiation Treatment of Carcinoma of the Uterus.
Radiation Treatment of Malignant Tumors of the Mouth and Pharynx.
Radiation Genetics.
Mitogenetic Radiation.
Structure Analysis.
Identical Physical Measurement of the Dose in Roentgen and Radium Treatment.
Hard Gamma Rays, Cosmic Radiation, Earth Radiation.
Short Wave Therapy.

The speakers have been chosen after consultation between the Committee and the radiological societies of the respective countries. Every member is entitled to take part in the discussion. Further, special invitations to participate will be issued by the Committee to certain members. In addition discussions will be held in the six sections and every member is entitled to present a communication of fifteen minutes. The choice of the subject is free, but the Committee suggests the following as being of special interest and will welcome such contributions:

Radiological Diagnosis

Roentgen Kymography.
Factors in the Production of the Mucosa Autoplastic.
Roentgen Investigation of Skeletal Movement.
Roentgen Investigation of the Mamma.
Sources of Error in Cholecystography.
Gastric Diagnosis Using Air Distention.

Radiotherapy

Possibilities of High Speed Cathode Rays.
Treatment with Highest Tension Roentgen Rays.
Comparison between Teleradium and Deep Roentgen Rays.
Principles in the Construction of Cancer Statistics Showing the Result of Treatment.
Principles and Practice in the Treatment of Metastases (Surgery, Roentgen Rays, Radium, Local and Distant Radium).
The Applications of Radiotherapy to the Sympathetic System.

Radiobiology

The Quantum Problem with Respect to Radiobiology.
The Relation between Quality and Biological Effect of Short Wave Radiations.
Radiohistology.

Radiophysics and Technique

Protection during Screening.
Measurement of Tension and Current of a Roentgen Tube. Questions of Exposure.
Film vs. Paper.
Chemical Effects of Short Waves Diathermy.
Absorption Effect and the Production of Secondary Radiation (Transitional Effects).

Electrology

End-Results of Electrocoagulation.

The Production of Alternating Electric Fields of High Frequency and their Biological Effect.

HELIOTHERAPY

Acclimatization to Visible Rays.
Infra-Red Radiation.
Long Ultraviolet Waves.

Members who wish to present a paper should notify the General Secretary before January 1, 1934, and supply him with a typewritten summary (not exceeding 400 words) in German, French or English before April 1, 1934. These summaries will appear in the special volume which will be issued to all the ordinary members before the beginning of the Congress.

In connection with the Congress an exhibition of apparatus, photographic accessories, chemical products and scientific books will be organized. (Applications to A. Strelin, Rämistrasse 7, Zurich.)

The delegates chosen to represent the United States are as follows: Dr. B. H. Orndoff, Chicago, President; Dr. Lawrence Reynolds, Detroit, Vice-President; Dr. Albert Soiland, Los Angeles, Secretary-Treasurer; Dr. Byron H. Jackson, Scranton, and Dr. G. Failla, New York. The President of the Congress is Dr. H. R. Schinz, Zurich, and the General Secretary, Dr. H. E. Walther, Gloriastrasse 14, Zurich.

AUDITORY EFFECTS OF ROENTGEN RAYS

A CORRECTION

To the Editor:

I wish to take this opportunity to correct an error that occurred in the article on the "Auditory Effects of Roentgen Rays in Dogs" by myself and Mr. Culler, published in the August, 1933, issue of the Journal.

The error is located in the data of Dog No. 2. On page 217, the means (averages) of the tests are given as 47.7, 48.4, 54.9, and 55.2, the latter values representing the increased acuity after irradiation. These latter averages are larger than the true means which, with their respective standard deviations, are: 51.8 ± 3.1, and 53.9 ± 2.3. The positions of the means on the graph (Fig. 4) on page 219 are correct and coincide with the true values given here.

The gain in acuity, though smaller than originally given, is still a significant change, since no value of P—as calculated with the new averages—approximates the "chance" probability. Computing the table of probabilities with these values, the values for P are found to be 0.0168, 0.0007, 0.0033, and 0.0003. A difference is considered as a chance occurrence when the P value is equal to, or greater than, 0.02.

EDWARD GIRDEN

NEW OFFICERS

AMERICAN ROENTGEN RAY SOCIETY

The following officers were elected for the year 1933-1934, American Roentgen Ray Society, at the first American Congress of Radiology: President: Dr. T. Murphy, Toledo, Ohio; President-Elect: Dr. George W. Grier, Pittsburgh, Pa.; 1st Vice-President: Dr. L. R. Sante, St. Louis, Mo.; 2d Vice-President: Dr. H. J. Walton, Baltimore, Md.; Secretary: Dr. E. P. Pendergrass, Philadelphia, Pa.; Treasurer: D. E. L. Jenkinson, Chicago, Ill.; Member of Executive Council: Dr. Sherwood Moore, St. Louis, Mo.

NEW OFFICERS

AMERICAN RADIUM SOCIETY

The following officers were elected for the year 1933-1934, American Radium Society, at the first American Congress of Radiology: President: Dr. Rollin H. Stevens, Detroit, Mich.; President-Elect: Dr. Willlam H. Cameron, New York City; 1st Vice-President: Dr. George W. Grier, Pittsburgh, Pa.; 2d Vice-President: Dr. John W. Cathcart, El Paso, Texas; Secretary: Dr. Edward H. Skinner, Kansas City, Mo.; Treasurer: Dr. Zoe A. Johnston, Pittsburgh, Pa.

DEPARTMENT OF TECHNIQUE

Department Editor: Robert B. Taft, M.D., 105 Rutledge Ave., Charleston, S. C.

DOG BOARD FOR OBTAINING SYMMETRICAL THORACIC ROENTGENOGRAMS

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THE angular prominences of the dog's thorax in back and front make it difficult to obtain perfectly symmetrical roentgenograms of the chest without the use of a special retaining device. The author has found the device here described the most satisfactory, not only because it fulfills the primary purpose extremely well but also because it greatly facilitates directing the roentgen rays over any chosen point, and is simple and portable.

The base is wooden and has a depression in the upper surface which is converted into a cassette tunnel by a roof of aluminum. The roof has a deep groove along the middle with flanking elevations, to retain the dog's spine. A pole stands on the base, at the center of one of the sides, which is parallel to the groove, and it carries pivoted on the top a horizontal arm long enough to reach entirely over the cassette tunnel. The arm carries a movable sleeve from which hangs a line and plummet, the line passing through a hole in the sleeve so that it can be pulled up easily. A spring-ratchet on the post fixes the arm in any desired direction,

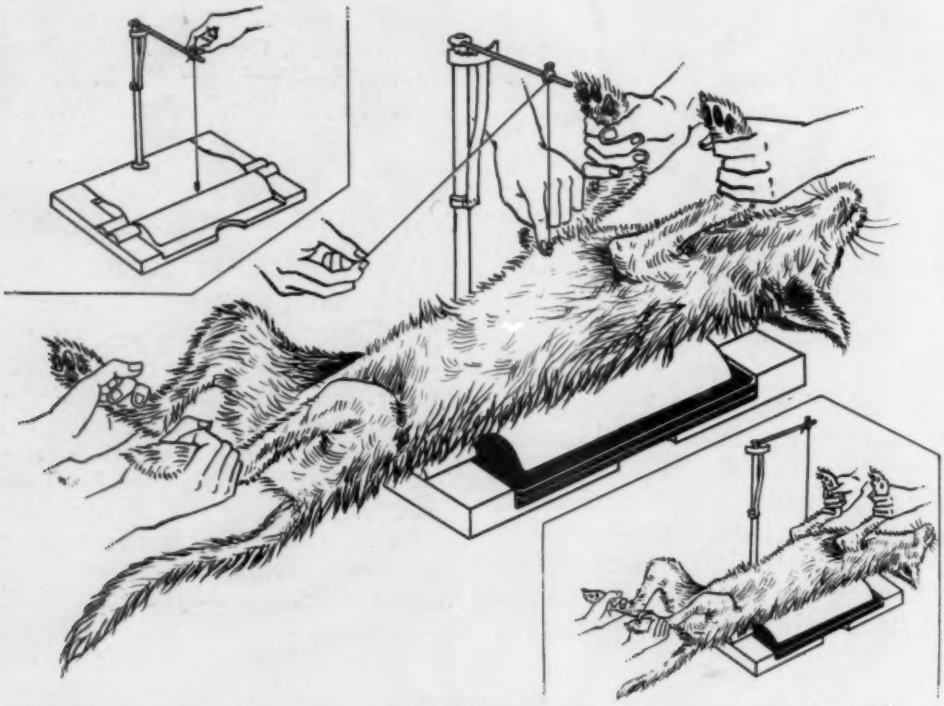

Fig. 1. Above: preparation of the board—centering the plummet over the groove. Middle: placement of the dog—centering the mid-point of the diaphragm (in this case) under the plummet. Below: position at the time of exposure.

and a set-screw on the sleeve fixes that structure at any desired point.

The board is prepared for use (Fig. 1, upper view) by adjusting the position of the arm and sleeve so as to bring the plummet over the point where the rays are to be centered, usually the center of the cassette tunnel (when the arm is put at right angles to the groove and the sleeve is fixed with the plummet hanging directly over the groove). The apparatus is then placed on the roentgen table with the sleeve centered under the roentgen tube, a loaded cassette is inserted in the tunnel, and the roentgen machine is prepared for the exposure. The dog is placed on the board (Fig. 1, mid view) with the spine in the groove, and the point on the chest over which it is desired to center the rays, usually one on the midline of the sternum, is located with the finger tip, while the plummet is drawn up near the upper surface of the chest and the dog's position is adjusted to bring the finger tip under the plummet. The arm is now swung aside (Fig. 1, lower view) and the exposure is made.

SAFETY DEVICE FOR DOUBLE FOCUS COOLIDGE TUBE*

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ONE of the reasons why we hesitated to install a double focus tube in this laboratory was the danger of accidentally overloading the fine focal spot and ruining the tube. This danger was eliminated by placing in the fine focus filament circuit a fixed resistance of such capacity that the maximum current through the fine focus

FIG. 1

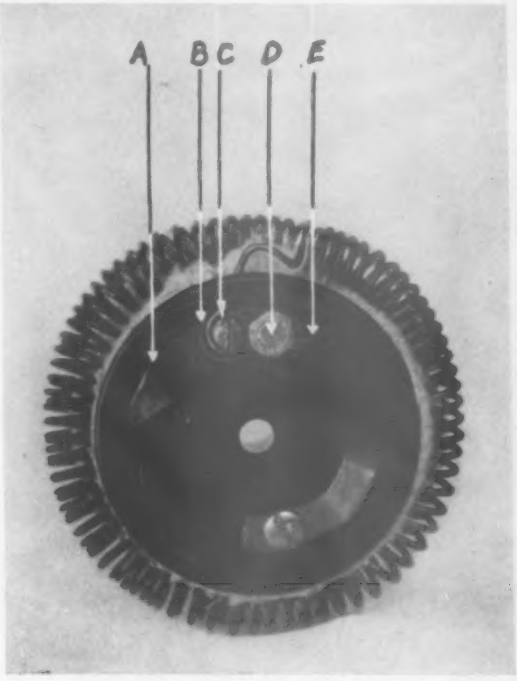

FIG. 2

* From the Department of Roentgenology of the Evans Memorial for Clinical Research and Preventive Medicine, Massachusetts Memorial Hospitals, Boston.

of the tube is 15–20 ma. when the filament control is at its maximum setting. This was accomplished by disassembling the switching device (Fig. 1) on the tube and replacing the bronze spring clip carrying the small filament current with a new and longer one (Fig. 2, *A*) made so that the screw (*C*) which held the old spring is insulated from the new spring by a fiber washer (*B*) through a larger hole in the spring, and a second screw (*D*), placed a short distance back, holds the spring in place and makes contact with it. The resistance wire (No. 18) is wound in a coil of about the diameter of a screen-door spring and this coil is wound in two turns around the outside of the switching device. The ends of the resistance are passed through small holes (*E*) drilled in the bakelite and are fastened to the screws of the bronze spring clip. A strip of asbestos wicking is placed under the coils and a narrower strip is placed between the coils for heat and electrical insulation. The proper length of resistance necessary to cut the filament current will vary with each installation, and should be worked out by trial. In practice this alteration of the switch can be made by any handy-man with little or no expense and is a workable prevention of unfortunate accidents on the part of the technician.

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN AND RADIUM THERAPY

Bistolfi, Stefano. La roentgenterapia nelle malattie a sindrome emorragica. (Roentgen treatment in diseases with a hemorrhagic syndrome.) *Radiol. med.*, 1932, *19*, 773–820; 889–933.

The author discusses the physiopathology of various diseases with a hemorrhagic syndrome, including hemophilia, Werlhof's disease, hemorrhagic capillary toxicoses and familial and sporadic pseudo-hemophilias, and considers the action of roentgen irradiation not only in these diseases but in controlling operative hemorrhage.

In all these diseases there are factors both in the blood itself and in the vessels to be considered. It seems to be proved that roentgen irradiation causes increased calcium metabolism, that is, more rapid elimination of calcium by the tissues and consequently a higher calcium content in the blood. It also causes increase of the number of cells, particularly leucocytes and platelets and increased coagulability. The increased number of cells, in addition to improving the general condition of the patient, may have a direct action in producing hemostasis. The rays also seem to have a good effect on obscure factors in the capillary walls. In Werlhof's disease intense irradiation of the spleen should be tried before resorting to splenectomy, and roentgen treatment has also proved effective in the treatment of recurrences after splenectomy.

Increased coagulability is brought about by small doses—$\frac{1}{4}$ to $\frac{1}{3}$ of a skin erythema dose—but the author does not believe that large doses cause retardation of coagulation. The ready hemorrhage sometimes seen after intense irradiation he thinks is caused by leucopenia and decreased number of platelets.

Irradiation should not be applied in all diseases with a hemorrhagic syndrome; it would be absurd to use rays, for instance, in a disease such as scorbutus in which causal treatment is so successful. Irradiation should be tried however in the different hemorrhagic diseases and utilized in those in which it has even a temporary good effect on the pathogenic factors.—*Audrey G. Morgan.*

Zaccaria, Antonio. Risultato della roentgenterapia in una oscura lesione della teca cranica, diagnosticata come osteoporosi circumscripta di Schüller. (Results of roentgen treatment of an obscure lesion of the skull diagnosed as Schüller's circumscribed osteoporosis.) *Radiol. med.*, Aug., 1932, *19*, 857–864.

A case of extensive lesion of the bones of the skull in a peasant twenty-four years of age is described. The author made a probable diagnosis of Schüller's circumscribed osteoporosis of the second type. This diagnosis was confirmed by Schüller himself to whom roentgenograms were sent, and by a number of eminent Italian roentgenologists. The differential diagnosis from syphilis, tuberculosis and Paget's disease is discussed.

The patient was irradiated four times at intervals of five days with doses of $\frac{1}{4}$ of a skin erythema dose, 220 kv., 40 cm. spark gap, 40 cm. focus-skin distance, filter 4 mm. aluminum and 0.5 mm. zinc, Coolidge tube, 2 ma. After a month and a half this series was repeated. This resulted in almost complete recalcification of the decalcified area and almost complete restoration of vision, but the severe headache of which the patient complained persisted, which suggests the possibility that this may be a prodromal stage of Paget's osteitis.—*Audrey G. Morgan.*

Jönsson, Gunnar. Case of xanthomatosis treated by teleradium. *Acta radiol.*, 1932, *13*, 518–526.

The author discusses the clinical picture and pathology of xanthomatosis and describes a case in a child born Nov. 29, 1928. In May, 1930, when fifteen months old, she suffered a blow over the left eye, followed by a swelling of the eyelid. This swelling persisted for six months in spite of incision and in January, 1931, another swelling developed in the left temporal region. On admission to the Radiumhemmet, March 16, 1931, she showed another swelling

in front of the ear. She presented exophthalmos and the roentgen and histological picture of xanthomatosis with areas of destruction in the skull bones.

Radium irradiation was given from March 16 to 29, 1931, with Sievert's teleradium apparatus. Four fields were irradiated, one over the eye, one in front of the ear, one at the site of the temporal swelling and one in the parietal region. A total dose of 19.5 gram-hours was given at a distance of 6 cm. with a filtration equivalent to 6 mm. lead. Daily doses of 1.5 gram-hours (3 grams for ½ hour) were given alternately on the different fields. Improvement was noticed during the treatment and on April 14, two weeks after it was finished, the swellings were no longer palpable and there was further improvement in the child's general condition. The middle of June she was given a second series of 1.5 gram-hours over three of the fields.

Since April, 1931, she has shown no clinical evidence of the disease and there has been a steady improvement in the roentgenograms. This is the only case treated with radium that has been published.—*Audrey G. Morgan.*

Collin, E. La radiumthérapie du cancer de la lèvre surtout au point de vue de ses métastases. (Radium therapy of cancer of the lip, particularly from the point of view of metastases.) *Acta radiol.*, 1932, *13*, 232–238.

The author gives statistics of 101 cases of cancer of the lip all treated with radium. Implantation was used in only 4 cases; in all the rest the treatment was by direct superficial application of 50 to 250 mg. radium element. In some of the cases preliminary treatment was given with hard roentgen rays and in some with soft roentgen rays. He divides the results according to these three groups. The best results were obtained in the group treated with soft roentgen rays followed by radium therapy; in the group treated with radium alone the results were almost as good, and in the group treated with hard roentgen rays and radium they were decidedly inferior. The total percentage of cures was about 80 per cent. The effects of the soft roentgen and radium treatment were particularly good with reference to the development of gland metastases. There was a very small percentage of gland metastases in this group. This was probably because the lymphatic glands react differently to hard and soft rays.—*Audrey G. Morgan.*

Berven, Elis. Le traitement radiologique des tumeurs malignes de la cavite buccale. (Radiation therapy of malignant tumors of the mouth.) *Acta radiol.*, 1932, *13*, 213–231.

The Radiumhemmet is now using a combination of teleradium and endothermy for the treatment of the primary tumor in carcinoma of the mouth and a combination of radium and conservative surgery for the enlarged glands. Radium has proved superior to the quality of roentgen irradiation available at present.

The greatest technical improvement in recent years has been the introduction of the teleradium technique and the more widespread use of the interstitial implantation of radium needles in combination with endothermy. By means of the teleradium technique the quantity and quality of the rays and the tissue doses can be increased, which greatly increases the effectiveness of the irradiation. The interstitial implantation of radium needles in various parts of the tumor completes or supplements the dose given in the previous teleradium treatment. Endothermy removes any resistant tumor remnants without bleeding and without any risks of local reimplantation or spreading of the tumor. The routine treatment of the primary tumor consists of an initial teleradium treatment, which after the tumor has become clean, reduced in size and more definitely circumscribed, is followed by endothermy by simultaneous interstitial implantation of radium needles around the coagulated area. The treatment of the enlarged lymph gland areas consists of giving teleradium treatment at the same time the primary tumor is treated. Surgical treatment is indicated after the teleradium treatment if any gland metastases remain that are movable and easily removable. Otherwise only teleradium is used.

For the period of eleven years from 1916 to 1926 the results of radiation treatment have been healing for five years or more in 32 per cent of the cases of carcinoma of the tongue, 34 per cent of the cases of sublingual carcinoma. 18 per cent of those of carcinoma of the mandible and 26 per cent of those of buccal carcinoma. Among 278 patients with carcinoma of the mouth 76, or 27 per cent, are free from symptoms after five to eleven years. Among 28 patients with epithelioma of the tonsils treated from 1919 to 1924 with the old technique 25 per cent were primarily cured and 10 per cent were free of symptoms for one year. Among 18

patients with epithelioma of the tonsils treated from 1924 to 1927 with the new technique 55.6 per cent were primarily cured and 39 per cent were free of symptoms after three years. Among 25 patients with carcinoma of the tonsils treated from 1916 to 1927 primary cure was attained in 71.4 per cent, 48.6 per cent were free of symptoms for one year and 36.7 per cent for five years.—*Audrey G. Morgan.*

Merritt, Edwin A. Irradiation of the parathyroids in cystic disease of the bones. *J. Am. M. Ass.*, May 14, 1932, *98*, 1733–1734.

Endocrinologic study has demonstrated a definite relation between the parathyroid glands and the metabolism of calcium in the skeleton and many cases have been reported demonstrating the influence of parathyroid hyperplasia in the causation of cystic disease. This is a report of a case of cystic disease involving the femur which showed complete recovery within four months after administration of roentgen rays to the parathyroid glands was instituted. A series of exposures was given at intervals of three weeks using 5 ma., 135 kv., 10 in. distance and 5 mm. Al filter. Not only was the bone structure restored to normal but the general symptoms of hyperthyroidism and hyperparathyroidism practically disappeared. This case is apparently the first so treated.—*E. W. Hall.*

Rossoni, Riccardo. Contributo al trattamento radioterapico del maladie de Vaquez. (Roentgen treatment of Vaquez' disease.) *Radiol. med.*, Feb., 1932, *19*, 156–166.

A typical case of Vaquez' disease is described in which the red blood count had risen to 12 million. The patient was given roentgen treatment beginning in February, 1927. The upper and lower epiphyses of the bones were irradiated, so as to irradiate as much bone marrow as possible. Both the dorsal and ventral surfaces were irradiated with $\frac{1}{3}$ of a skin erythema dose per field, making a total of $\frac{2}{3}$ of an erythema dose for each epiphysis. The bones irradiated were the humerus, ulna and radius, tibia and femur on both sides and the sternum. The spleen was not irradiated. Two fields were irradiated a day for fifteen days, with a spark gap of 40 cm., 2 ma., filter 0.5 mm. zinc and 3 mm. aluminum, focus-skin distance 30 cm. The symptoms were accentuated for a little while and then the patient's condition began to improve progressively. Two further series were given in April and June and after that the patient was well for three years. Toward the end of 1930 the red blood count rose again to 7 million and some of the other symptoms reappeared. He was given two series of irradiations in January and February of 1931 and since that time has been well subjectively and objectively with a normal blood picture. The white cells showed leucopenia during the treatment, followed at the end by leucocytosis with no immature forms, showing that the bone marrow was functioning normally.—*Audrey G. Morgan.*

Heyman, James. Experiences with radiological treatment of cancer of the uterus and ovaries. *Acta radiol.*, 1932, *13*, 329–333.

The author briefly reports the results obtained at the Radiumhemmet in the treatment of cancer of the uterus and ovaries.

From Jan. 1, 1914, to Dec. 31, 1926, a total of 1,237 patients with cancer of the cervix was sent to the Radiumhemmet for treatment. Five years after the treatment 259 of these patients were living and free from symptoms. This is about 20 per cent absolute cures. Of those treated from 1914 to 1921 inclusive 16 per cent were living and free of symptoms.

There were 80 cases of cancer of the fundus in which the microscopic diagnosis was made at the Radiumhemmet from 1914 to 1926. Most of these were adenocarcinomas. Of these 42.5 per cent were living and apparently free of symptoms after five years.

Among the cases of carcinoma of the ovaries treated from 1914 to 1926 there were 24 inoperable cases; two of the patients were living after five years. Microscopic diagnosis was lacking in one of these cases. Among 36 cases operated on conservatively about 20 per cent were living after five years; among 28 recurrences after radical operation 25 per cent were living at the end of five years and among 46 cases operated on radically and given radiation treatment afterward about 54 per cent.—*Audrey G. Morgan.*

Neill, William, Jr. 126 cases of ovarian carcinoma treated by radiation. *South. M. J.*, July, 1932, *25*, 679–682.

One hundred and twenty-six cases of ovarian carcinoma treated by radiation, both roentgen rays and radium, are reported. Accurate tissue

diagnosis was made in all but 7, there being 108 papillary cystadenocarcinomas, 8 solid cell adenocarcinomas, 2 gelatinous papillary carcinomas and 1 Krukenburg tumor. The ages ranged from thirteen to seventy-five, averaging 42½, with the greatest number appearing in the decade forty to fifty; 106 were married. Eighty-two cases were bilateral The process was advanced in 112 cases when first seen. In 87 there was no improvement. In 32 there was definite palliation as to relief of pain and improvement of general health, lasting from three months to four years, with later resumption of the growth. Three cases apparently cured lived for 6, 10 and 2½ years, the latter dying of disease independent of the ovarian condition; 2 cases clinically well for 4 years and 3 cases apparently well for 4, 3 and 1½ years are reported in detail with factors of radiation therapy employed.—*W. R. Brooksher, Jr.*

MISCELLANEOUS

Picchio, Carlo. Dosimetria curieterapica. (Dosage in radium therapy.) *Radiol. med.*, Sept., 1932, *19*, 933–967.

The author gives a thorough review of the methods of radium dosimetry in use at the present time, discussing their merits and their faults. He then says that when the dosage of an apparatus cannot be measured directly by the ionomicrometer he has worked out a relation between the charge per unit of surface and its yield in Dominici units which is sufficiently accurate to be used for practical purposes in determining dosage. The values are affected of course by various factors, such as the distance of the focus from the skin, the filtration and the area over which the irradiation is distributed. He has taken these factors into account in the table which he gives showing his results. The limits of error are small enough so that the method can be used for forms of apparatus that are not too much curved; for these he thinks direct measurement should always be used.—*Audrey G. Morgan.*

Barnard, Margaret W., Amberson, J. Burns, Jr., and Loew, Marion F. The technique of using paper films for roentgenograms of the chest. *Am. Rev. Tuberc.*, June, 1932, *25*, 752–766.

This is a statement of the technical procedures employed at the Bellevue-Yorkville Health Demonstration with a new type of paper film. This film, coated on one side, is used practically the same as the celluloid film, requiring an increase in exposure time of 100 to 200 per cent with a slightly increased kilovoltage peak. A special developer is required. After finishing, the film is viewed by direct illumination with bright daylight. While the celluloid film is appreciably superior for showing shadows of fine detail, the paper film approximates this desired standard very closely. It possesses the frequently desired advantage, particularly in a large series, of about 50 per cent less cost. A series of comparative illustrations accompany the article.—*W. R. Brooksher, Jr.*

White, Paul D., and Camp, Paul D. A comparison of orthodiagraphic and teleroentgenographic measurements of the heart and thorax. *Ann. Int. Med.*, Oct., 1932, *6*, 469–481.

The authors report on the comparative study of the heart and thoracic measurements in a series of 22 individuals, 10 normal and 12 with abnormalities of the heart, aorta and pericardium. In each of the diameters measured the teleroentgenographic average was greater than the orthodiagraphic, and the thoracic measurements showed greater difference than the cardiac. The transverse cardiac diameter averaged 1 cm. greater by teleroentgenographic measurement than by orthodiagraphic (in an extreme case 1.8 cm.). The cardiothoracic ratio was essentially the same by either method in both groups. Measurements by teleroentgenography were consistently greater as established by controls in all cases. A greater cardiac area measurement by teleroentgenography was a uniform finding and averaged 15 to 25 per cent in these cases. The difference between the two methods is great enough to render direct comparison misleading, and thus in giving roentgen measurements of cardiac and intrathoracic diameters and of the cardiac area, it is essential to state by which method the measurements were obtained.—*W. R. Brooksher, Jr.*

Cignolini, Pietro. Metodi e mète della chimografia cardiaca (Roentgenmiografia cardiaca.) (Methods and objects of kymography of the heart—cardiac roentgen myography.) *Radiol. med.*, April, 1932, *19*, 401–405.

In 1912 Gott and Rosenthal proposed the first method of kymography of the heart. The

x-ray bundle which had traversed the chest of the patient was intercepted by a lead screen except for a narrow fissure running transversely and following a horizontal or oblique diameter of the heart. The roentgen film was moved with a uniform motion behind the lead screen, giving a picture of the successive positions assumed by the heart outline. The movements of the heart were registered in an accurate and legible way. The method had disadvantages, however, and the author mentions various improvements made in it up to his own method in which short segments of the fissure are placed in chosen positions on the heart outline and a kymographic record obtained of the movements of those sections. He takes, for instance, a point on the left ventricle, one on the right ventricle, one on the right auricle and one on the aorta and makes an accurate analysis of their movements which are recorded. He gives illustrations from cases of auriculoventricular dissociation. He thinks the method is a valuable contribution to the study of the physiology and pathology of the circulatory system.—*Audrey G. Morgan.*

Ziedses des Plantes, B. G. Eine neue Methode sur Differenzierung in der Röntgenographie-Planigraphie. (A new method of differentiation in roentgenography—planigraphy.) *Acta radiol.*, May 15, 1932, *31*, 182–192.

A method is described by which it is possible to obtain a sharp roentgen picture of any one plane in the object examined while parts lying outside that plane are rendered indistinct. For this purpose the tube and the film or plate are moved in opposite directions throughout the exposure time in such a way that the projection of all points in the plane selected always strike the film at the same place while the projections of all points outside that plane change their position.

A method is also reported which makes it possible to project several planes at the same time and a simple apparatus described by which the height of the plane can be registered. An example is given showing how reliable measurements can be made on the roentgenogram by means of this new method of projection. Some difficulties in the interpretation of the roentgenograms that are of special interest are discussed.—*Audrey G. Morgan.*

Jaeger, W. Über einen scharfzeichnenden Film für Folienaufnahmen. (A film for taking folio pictures with sharp outlines.) *Acta radiol.*, May 15, 1932, *13*, 178–181.

By adapting the construction of a double-coated film to the special optical conditions required for making roentgenograms in folio size, the author has succeeded in obtaining a considerably greater sharpness of outline in the pictures without any changes in the practical manipulation of the films. No increase of exposure time is necessary; the developing time is lengthened a little. Illustrations are given showing the gain in sharpness of outline.—*Audrey G. Morgan.*

Ribbing, S. Beitrag zur röntgenologischen Pelvimetrie und Zephalometrie in utero. (Roentgen measurement of the pelvis and head in the uterus.) *Acta radiol.*, 1932, *13*, 591–598.

One of the chief objects of obstetrical roentgen diagnosis is to determine the form and size of the pelvis and of the head of the fetus. The best way of determining the general form of the pelvic inlet is by taking a roentgenogram in Albert's semi-sitting position. The length of the true conjugate can best be measured on a lateral roentgenogram of the pelvis by Guthman's method. The transverse diameter and the head of the fetus can be measured accurately and simply by orthodiagraphy by Moritz' method which does not seem to have been used heretofore in the measurement of the pelvis.—*Audrey G. Morgan.*

Franke, Heinrich. Die Norm im Röntgenbild. (Standards in roentgenography.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Dec., 1931, *44*, 691–711.

This is a technical article which through the German Roentgen Society won the first prize of the Schleussner Company. It deals with (1) considerations of the sensitometry of roentgen emissions; (2) the constancy of the roentgen source; (3) the sensitometric system; (4) the relation of the threshold sensitivity, gradation, and fogging to the form and position of the sensitometric curves; (5) the accuracy of the disc of the sensitometer; (6) the sensitometric disc and its systems of exposure; (7) development and gradation; (8) the influence of additional exposure on the gradation; (9) the intensifying factor, and (10) the making of roentgen copies.—*T. Leucutia.*

Brunetti, Lodovico. In difesa del mio metodo personale dell'assunzione crociata dei due canali ottici a cranio fisso su stessa film. (In defense of my personal method of taking the two optic canals crossed on the same film with the head fixed.) *Radiol. med.*, Sept., 1932, *19*, 1030–1036.

This is an extremely technical discussion of the author's own method of taking roentgenograms of the optic canals which has been criticized by Prof. Giordano.—*Audrey G. Morgan.*

Krebs, Carl, and Schmit-Jensen, H. O. Experiments with roentgen irradiation of pure vaccinia lymph and of a lymph sample contaminated with foot-and-mouth disease virus. *Acta radiol.*, 1932, *13*, 349–361.

Roentgen irradiation of vaccine lymph in doses of from 3,600 to 36,000 r apparently did not decrease its infectiousness. In 275 children scarified on the left arm with irradiated vaccine and on the right arm with non-irradiated vaccine there was not the slightest difference in the results on the two arms. It will require further experiments with titrated doses of virus to determine whether roentgen irradiation has any effect on the total amount of live particles of virus in such emulsions or not.

Roentgen irradiation of a cowpox vaccine accidentally contaminated with a foot-and-mouth disease virus with doses of 38,000 and 25,000 r did not kill the foot-and-mouth disease virus. Two heifers inoculated with irradiated virus and one heifer and a ram inoculated with non-irradiated virus all showed typical generalized foot-and-mouth disease. The authors have the impression that the roentgen irradiation stimulated rather than weakened the effect of the foot-and-mouth disease virus.—*Audrey G. Morgan.*

Cappelli, Luigi. Esperienze sulla celluloide, proposta quale supporto nelle applicazioni radiumterapiche. (Experiments with celluloid as a support for radium preparations.) *Radiol. med.*, Aug., 1932, *19*, 825–835.

In a previous article the author proposed the use of celluloid as a support in the application of radium preparations. He has now made comparative chemical and biological experiments with nitrocelluloid and acetyl-celluloid and finds that the latter is superior to the former. The nitric acid in the former is replaced by acetic acid and the camphor by an oil which is probably castor oil so that the acetyl-celluloid does not cause the slightest irritation. It is non-inflammable and much more plastic than nitrocelluloid. It is much lighter than Columbia paste and cannot be broken or bent, as the latter can. Acetyl-celluloid is as transparent as glass, much more so than nitrocelluloid and the author believes it is the best material available for making radium supports.—*Audrey G. Morgan.*

Jansson, Gösta. Über die Einwirkung der Röntgenstrahlung auf die Fähigkeit der Geschwülste Iod and Wismut zu speichern. (The effect of roentgen irradiation on the capacity of tumors for storing iodine and bismuth.) *Acta radiol.*, 1932, *13*, 533–550.

The author describes experiments that he made for the purpose of determining whether roentgen irradiation affects the capacity of tumors for storing bismuth and iodine. With reference to iodine he found that small doses of irradiation do not affect the storage capacity of the tumors. Larger doses decrease the capacity of the tumor for storing iodine, no matter whether the irradiation is filtered or unfiltered. The effect is not apparent for the first twenty-four hours and is not marked until after several days.

The effect on the storage of bismuth is just the opposite. It is increased by irradiation. These statements refer to the immediate effect of irradiation. The observations were not continued for more than a week and it is not known whether there was any later effect.—*Audrey G. Morgan.*

Lambert, J. Contribution à l'étude de la radiosensibilité des graines au début de la germination. (Contribution to the study of the radiosensitivity of grains at the beginning of germination.) *Compt. rend. Soc. de biol.*, Oct. 16, 1931, *108*, 240–244.

The authors performed a series of experiments on peas in various hydrolyzed conditions by irradiating them in lots of 40 to 50 with a dose of 10,000 r (Solomon), 200 kv., 20 cm. distance, 1 mm. Al filter, 80 min. exposure. It was found that the dry peas were more resistant to irradiation than those soaked for eighteen or twenty-four hours in wet sawdust, but that they were less resistant than those irradiated after six or twelve hours of hydration.—*T. Leucutia.*

Lindblom, Adolf F. On the effects of various iodized oils on the meninges. *Acta med. Scandinav.*, 1931, *76*, 395–402.

Odin and Runström in 1928 in dealing with myelography called attention to the irritating effect of the various oils on the meninges. The experiments on which this assertion was based were performed by the author. He since then has continued them and now arrives at the following conclusions: The vegetable oils (soy, linseed, poppy) are less irritating than the animal oils (cod liver oil). The cause of irritation lies in impurities (fatty acids, iodic fatty acids and sometimes hydrogen iodide) in the vegetable oils, and in very rapid splitting in the animal oils. If the impurities are eliminated, vegetable oils may be used safely as contrast media. Still one has to consider that under certain conditions a fatty granuloma may occur later. The animal oils are entirely useless and should therefore be rejected.—*T. Leucutia.*

Lambin, P. Influence du dioxyde de thorium colloïdal (thorotrast) sur la formule sanguine. (Influence of colloidal thorium dioxide (thorotrast) on the blood formula.) *Compt. rend. Soc. de biol.*, Oct. 16, 1931, *108*, 264–266.

The authors studied the hematologic modifications secondary to injections of thorotrast in rabbits. It was found that a large dose of 5 c.c. produces a distinct anemia whereas smaller doses of 1 c.c. may lead to a discrete erythroblastic reaction. It was interesting that the reticulocytes presented no increase in number after twenty-four hours. It seems thus that the thorotrast produces an initial erythroblastosis without reticulocytosis, similar to that observed by Wuyts and Morelle after injection of saponin and colloidal sulphur. The variations in the total number of red and white elements resembled those observed after the injection of most of the colloidal substances. An initial and generally very short phase of leucopenia with relative lymphocytosis was followed by a long phase of leucocytosis with polynucleosis. The peak of the polynucleosis was occasionally followed by monocytosis and after stronger injections by passage into the blood of histiocytes loaded with thorotrast.

A long sojourn of the thorotrast in the reticulo-endothelial cells fortunately permits the injection of the thorotrast in fractional doses, thus preventing the occurrence of anemia, but it remains to be determined whether or not this produces a radioactive effect on the organism in general and on the hematopoietic system in particular.—*T. Leucutia.*

Osment, C. G. Experimental radiography utilising the gamma rays of radium. *Brit. J. Radiol.*, March, 1932, *45*, 269–274.

Considerable benefit is derived from the use of radium as a source of radiation in the examination of metals. With the known apparatus rather successful results have been obtained with the roentgen rays for thicknesses of steel and iron up to about 3½ inches. The introduction of gamma rays of radium would permit radiography of the metals above that thickness. In this article the author discusses the amount of radium necessary for various exposures and thicknesses of steel and includes some very instructive radiographs taken by radium to prove the value. To take one single example: a radiograph of 5-inch steel at a distance of 30 inches would require 0.5 mg. of radium, while 6 inches of steel at the same distance would require over 1 gram if the exposure time were limited to fifteen hours.—*T. Leucutia.*

Spear, F. G. Summary of paper on the effect of split doses of gamma radiation on tissue cultures in vitro. *Brit. J. Radiol.*, Dec., 1931, *4*, 680.

(*a*) *Effect on Mitosis.* Exposure of cultures to 100 mg. radium (element) at 0.5 cm. for 2½ minutes causes a diminution in mitosis followed by a compensatory increase. Exposure for five minutes produces a similar effect.

Two irradiations, each of 2½ minutes, give a different effect from a single exposure of five minutes. The effect further varies with alteration in the interval between the exposures. An interval of eighty minutes is more effective in bringing about a diminution in mitosis than an interval of 160 minutes.

(*b*) *Lethal Effect.* When cultures are exposed to 300 mg. radium at 0.5 cm. for six hours, a delayed lethal effect follows, and all the cultures die within sixteen days. In this case it is immaterial whether the dose is given all at once or in six fractions of one hour each at intervals of twenty-four hours.

(*c*) *Enhanced (Lethal) Effect from Splitting a Given Dose.* A similar delayed lethal effect can be obtained by a much shorter total irradiation if the dose is appropriately divided. By this

means the effect of a given irradiation may be greatly enhanced. Exposures to 300 mg. radium for 2½ minutes at intervals of eighty minutes, until a total exposure of one hour has been given, produces a delayed lethal effect equivalent to that following a continuous irradiation of 4½ hours.—*T. Leucutia.*

Dognon, A., and Piffault, C. L'action des rayons x sur les protozoaires et le problème de la sensibilisation. (The action of roentgen rays on protozoa and the problem of sensitization.) *J. de radiol. et d'électrol.*, Aug., 1931, *15*, 442–446.

The authors constructed a special roentgen tube yielding a very large amount of radiation. This was obtained by reducing the distance of the anticathode from the window of the tube to only 25 mm. and by giving the anticathode a parallelepiped form, so that by simple rotation each of the four surfaces is successively exposed to the cathode beam. The rays emerge through two symmetric windows of 7 mm. diameter each. With 15 ma. and 16,500 volts (10 micron aluminum window, tungsten anticathode) a radiation of 1350 r per second is obtained. This destroys the ascaris egg in less than a second and produces a complete sterilization of a *B. pyocyaneus* culture in five seconds.

By making use of this tube, the authors were able to produce death of protozoa (paramecia) within normal conditions. The dose leading to immediate death was 500,000 r, whereas half of this dose produced no visible effect, the divisions continuing normally. Various toxic solutions led to shortening of the time of death (in some instances from 3 to 1) due, no doubt, to increase in the cellular sensitivity. Other solutions (resorcin, sodium hyposulphite), even in toxic concentration, failed to influence the time of death or counteracted the effect of the previous solutions, thus acting as desensitizers.—*T. Leucutia.*

Souttar, H. S. On fields of radiation from radon seeds. *Brit. J. Radiol.*, Dec., 1931, *4*, 681–689.

The problem which the author proposes to solve is that of producing a uniform field of radiation in which the cancer cells will be destroyed while the tissue cells are not affected. He uses radon seeds and by means of a special apparatus places them so as to obtain a uniform radiation on the area treated. For this purpose he adopted a mathematical formula permitting the calculation of a continuous distribution of the radiation throughout a sphere and throughout a circular ring. Curves of constant radiation were drawn. To give one example, for the treatment of carcinoma of the cervix a ring pessary is formed with a thick body of rubber and a core consisting of a gold or platinum tube. The circular core contains a suitable amount of radium or its emanation which is doubly screened by the gold or platinum tube and by the rubber which surrounds it. Such a pessary can be easily placed in the upper part of the vagina so that it encircles the cervix of the uterus. In this manner the cervix, as well as the whole contents of the pelvis, is subjected to a radiation of remarkable uniformity sufficient to destroy all secondary deposits in the lymphatic glands.

It must be mentioned, however, that inasmuch as the procedure applies mathematical analysis to clinical problems, the whole question of absorption and secondary radiation is not considered. The author is dealing solely with the question of getting a flat radiation from a theoretical distribution. As the author states, his purpose was to put forward simple examples which may be suggestive to his surgical colleagues and may perhaps stimulate the interest of physicians in one aspect of a fascinating and important problem.—*T. Leucutia.*

Mayneord, W. V. The measurement in "r." units of the gamma rays from radium. *Brit. J. Radiol.*, Dec., 1931, *4*, 693–710.

Summary. The paper discusses the physical aspects of the problem of dosage in radium therapy. Various units are discussed and reasons given for the choice of the r unit. Experimental arrangements are described, including a small ionization chamber suitable for measurements in the vicinity of a radium needle containing a few milligrams of radium element. The apparatus is calibrated in r by subjecting the chamber to a beam of hard roentgen rays, which is simultaneously measured by means of a second thimble chamber. The distribution of intensity around a 5 milligram needle is mapped out. The intensities in r/mg/hr. are measured and found to be in agreement with experiments by Glasser. Using probable data, the intensity of radiation at definite distances from a radioactive source are calculated and shown to agree with the experimental results. The relationship

between the international r and the Solomon R is calculated, and it is shown that 1 r/sec = 1.65 R. This value is in good agreement with experimental results. The "unit skin dose" is of the order of 1,800 r for hard γ rays. The Mallet D unit and U.S.D. of Martin and Quimby are discussed and shown to be probably of the order of 117 r and 1,400 r respectively.—*T. Leucutia.*

Stoenesco, P., and Craciun, E.-C. Sur la présence des rayons secondaires dans l'organisme au cours de la radiothérapie profonde. (On the presence of secondary rays in the organism during the course of deep radiotherapy.) *Compt. rend. Soc. de biol.*, Oct. 16, 1931, *108*, 325–326.

The authors placed a fluoroscopic screen in the abdomen of a dog during roentgen irradiation of the thorax, the remaining part of the animal being covered with lead, and found that there was a fluorescence of the screen. This indicates that secondary radiation is produced no matter how well the protection is applied. The same degree of impression was observed whether the screen was placed below or above the liver. It is concluded that the liver is always submitted to a certain action of the roentgen rays during irradiation of the thorax.—*T. Leucutia.*

Solomon, Iser. Nouvelles recherches ionométriques. (New ionometric researches.) *J. de radiol. et d'électrol.*, Aug., 1931, *15*, 432–441.

This article deals with the present status of ionometry in medical radiology and with the more recent researches of the author on the subject.

I. The ionometers may be generally divided into two groups: (1) the so-called variable potential ionometers in which the apparatus are charged to a certain potential and the discharge due to the ionizing action of roentgen, gamma and ultraviolet rays is estimated by the drop of potential as read on the graduated scale of the apparatus, and (2) the so-called constant potential ionometers in which the potential remains constant and the ionizing action of the radiations is measured by the intensity of the current as read on the graduated scale. The first comprise essentially an electroscope, an ionization chamber and a connecting cable. They have the great advantage that they permit a direct reading of the applied dose. However, the insulation which must always be absolute constitutes one of the most delicate problems. The amber, sulphur and ceresin which are generally used unfortunately become feeble conductors during the action of the rays, producing an error occasionally as high as 30 per cent. By taking the necessary precautions (surrounding the tube and the instrument with lead, exposing only the ionization chamber to radiation, etc.), one may obviate this error. In connection with this the author describes his new charging device which is now added to the Solomon ionometer.

In the constant potential ionometers, the intensity of the current is measured, the apparatus thus functioning as intensivemeters. The total dose is then calculated by multiplying the intensity by the time of exposure. Inasmuch as the intensity of the ionization current is very weak, various appliances are used for amplifying it, as, for example (*a*) filling of the ionization chamber with a heavy gas (xenon in the chamber of Dauvillier), or (*b*) intercallating relay bulb amplifiers as practiced chiefly in Germany (Siemens). One must place in a group apart certain ionometers such as the mecapion, the ionometer of Hammer, etc., which use a three-electrode bulb as a relay in the grid circuit. The principal advantage of all constant potential apparatus is that the insulation can be entirely neglected. Still by comparing the two types of ionometers from the practical clinical standpoint there can be no doubt that those of variable potential because of their simplicity and sturdy construction have the greater advantages.

II. The recent important work of Glasser and Küstner and their collaborators concerning the best type of ionization chamber demonstrated the necessity of using a small ionization chamber completely independent of the wave length. The material advocated by the different authors varies greatly (Friedrich, graphite coated horn; Holthusen, graphite coated paper; the author, graphite; Glasser, magnesium coated graphite; Glocker, silicated graphite; Küstner, graphite coated cellophan), but it has in all instances the common feature that it is of a low atomic weight, the effective atomic number (Glasser) being in the neighborhood of that of the air (7.6).

The ionization chamber of the author's ionometer was recently subjected to severe criticism, especially by Murdoch and Stahel, by Reiss and by Gunsett and Mlle Cohn. A re-

check by the author himself of the experimental results given in the above critical articles (by using a comparison with two large ionization chambers) has led to the conclusion that if one disregards the error of 10 per cent which must be considered normal, the variation in the figures must be attributed chiefly to the fact that (*a*) part of the cable was included in the field of the ionization and (*b*) the ionization chamber was not centered properly, leading to the off-focus radiation of Taylor. By correcting these factors, the ionization chamber appeared from a practical standpoint independent of the wave length.

III. The Second International Congress of Radiology, Stockholm, in taking the electrostatic unit as the quantitometric unit of x-radiation made the error of defining this unit on the basis of the ionization of the air. Various experiments since then have proved that this ionization is difficult to obtain. Especially two factors are of paramount importance during the measurement: (1) variation of the results with change in the form and position of the diaphragm (as proved by Failla), and (2) distortion of the electric field with change of the form, position and charge of the electrodes (as proved by Schechtmann). To overcome the errors resulting from these factors Taylor of the Bureau of Standards of Washington advocates for standardization purposes the use of the zero method which is recommended also by Dauvillier, Laborde and Saget.

The author, by taking into consideration the above factors, has re-checked the value of the R (as measured on his ionometer) and compared it with the International r, first by using the zero method (with the Dolezalek quadrant electrometer and then with the Lindemann electrometer) and second, by connecting a large ionization chamber directly to his own electroscope. It was found that in both instances the ratio R:r was 2.2, which therefore must be considered as the true value of the ratio of these units.

Until an international congress will definitely establish the criteria under which the large ionization chamber may be used for standardizing purposes, the author proceeds with his ionometer as follows: The standardization into r is made by means of a radium source. The independence of the wave length of the ionization chamber is then determined by means of comparison with a large ionization chamber (which was constructed at the author's directions by the Compagnie Générale de Radiologie). The constancy of the ionization chamber is checked from time to time by using the so-called "ionometric control" with uranium oxide condenser (for its description, see abstract, this Journal, 1931, *25*, 574).

IV. The ionometer may be used with certain reservations also for the measurement of the gamma and ultraviolet rays. It must be mentioned, however, that the value of these measurements is only approximate.—*T. Leucutia.*

Poittevin. Générateur "Tripharix." ("Tripharix"generator.) *Bull. et mém. Soc. de radiol. méd. de France*, Nov., 1931, *19*, 458–464.

The Compagnie Générale de Radiologie of France has constructed a new roentgen-ray generating apparatus utilizing the principle of three-phase current with six kenotron tube rectification. The machine which is called "Tripharix" yields a current of from 40 to 140 kv. and from 0 to 10 ma. for roentgenoscopy and from 40 to 140 kv. and from 0 to 2,000 ma. for roentgenography.

The various parts as well as the control cabinet are described in detail. A very accurate timer is used which permits the cutting down of the exposure to 6/1000 of a second.—*T. Leucutia.*

Simon, G. Rationalisation of x-ray exposures. *Brit. J. Radiol.*, Jan., 1932, *5*, 65–73.

Summary. Exposures are recorded at the present time in terms of kv. peak, milliamperes and time (distance, and whether screens or Potter-Bucky is used). This is unsatisfactory in practice, for three main reasons: (1) difficulties of measurement, especially for very short exposures of high intensity; (2) insufficiency of data, as wave-form affects the significance of the kilovolt (peak) measurements, while the tube factor must be included; (3) lack of a photographic standard of speed.

Conclusions. Some of the present difficulties might be solved: (1) by giving up the measurement of kv. peak and substituting for it a unit of "radiographically effective kilovolts," obtained by measuring on one's own set the number of milliampere-seconds required to match a certain standard. The standard might be based on the kilovolts of a constant potential set, or a four- or six-valve set. Alternatively to work in terms of half-value absorption in, e.g.,

Al; (2) it is best to measure milliampere-seconds and time, in the case of very rapid exposures, rather than measure milliamperes directly; (3) the setting up of a photographic standard of speed, both for films and films when used with screens. It might be possible and convenient to calibrate this in "r" units at a certain radiographically effective kilovolts, to produce a certain blackening.—*T. Leucutia.*

Witka, W. A., and Dmochowsky, W. W. Eine neue Methode zur Messung der Spannung an der Röntgenröhre. (A new method for the measurement of the tension of roentgen tubes.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Jan., 1932, *45*, 78–91.

This is a very technical article dealing with the Hefeli method for the measurement of the tension of roentgen apparatus. The method consists briefly in the intercalation of two condensers, the tension being estimated from the intensity of the current which flows through the wire connecting the condensers. It was found that by using a ballistic milliammeter and an accurate timer, the method can be used advantageously for the measurement of the tension in alternating currents.—*T. Leucutia.*

Müller, K. W. Ein neues Hochspannungsvoltmeter zur direkten Messung der Röhrenspannung für Diagnostik und Therapie. (A new high tension voltmeter for the direct measurement of the tube tension for diagnosis and therapy.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Feb., 1932, *45*, 207–210.

The author constructed a high tension voltmeter which is based on the principle that the electric charge of a high tension condenser is measured ballistically, the charge being proportional to the peak voltage. The instrument which is gauged in kilovolts has an error of only ±1 per cent, and has proved of practical value in both diagnostic and therapeutic roentgen outfits. In the former, it permits the estimation of the voltage even in the shortest exposures, while in the latter it gives a constant control of the tube tension during the entire course of the treatment. A photograph of the instrument as well as several diagrams is included.—*T. Leucutia.*

Jeans, James. What is radiation? *Brit. J. Radiol.*, Jan., 1932, *5*, 21–38.

This article is the 14th Silvanus Thompson Memorial Lecture and deals in extenso with the various opinions on the nature of radiation. Thus the corpuscular and wave theories, the kinetic theory, the wave mechanics, the meaning of photons, electrons and protons and the electro-magnetic waves are discussed in a very lucid and masterly manner. The article is concluded with a very remarkable illustration of the futility of attempting to depict in words processes which do not admit of being depicted either in terms of words or of the ordinary concepts of physics. A single instance is cited. A hydrogen atom is generally represented by a system of waves (the electron) and a center of force (the nucleus) which affects the propagation of these waves and in fact directs it when no other forces are present. We can of course represent a second hydrogen atom in precisely the same way but if we want to represent two hydrogen atoms under one another's influence it is not enough to dump down two nuclei and two wave systems at the appropriate points of space. There is a new wave system to represent the pair of atoms but ordinary three-dimensional space is not enough to contain it. It requires six dimensions as we should actually expect if the wave system represents only our uncertainty as to the value of six quantities. If we now try to depict the transfer of energy which in fact is precisely the radiation in such a system we can readily see that a transfer needs six dimensions of space for its proper representation. When, as in a photograph or a picture, we try to force three dimensions into two, we create all sorts of inconsistencies, we see a mountain looking no bigger than a man, and a cloud no bigger than a man's hand. We must not be surprised if forcing six dimensions into three has similar results.—*T. Leucutia.*

Moppett, Warnford. A thermo-electric instrument for measuring total x-ray energy with a determination of the practical units. *Brit. J. Radiol.*, Feb., 1932, *5*, 159–168.

This apparatus was designed with a view to measuring total energy distributions, particularly if the theory holds that biological effects depend on the disturbance of "key atoms" rather than total ionization. Roentgen energy is (almost) completely absorbed by a plate of bismuth, and the increase in temperature at a bismuth copper junction generates a potential which is measured with a galvanometer. On

this basis, an apparatus was constructed by the author, assuming that all absorbed energy by the instrument is converted into heat. The apparatus is described in lengthy detail and illustrated with a photograph and diagrams. Some very interesting conclusions were obtained concerning the value of the Solomon R and of the international r in measuring the roentgen-ray dosage.—*T. Leucutia.*

Moppett, Warnford. The variation of total x-ray energy with potential. *Brit. J. Radiol.*, March, 1932, *5*, 250–251.

It is generally accepted that roentgen-ray energy varies as the square of the exciting potential. By making use of a thermo-electric instrument (see above abstract), the author checked up the value of this law over a range of hard radiations used for radiotherapy (90 to 150 kv.). The figures obtained confirmed the law. As most previous work has been carried out with soft radiation and an ionization chamber, this new observation with harder rays is of distinct value. To give an extreme example: if the potential is inadvertently doubled, the roentgen-ray energy would be increased by a factor of 4. As may be expected, the total energy varies directly as the milliamperage for the range covered (3, 6 and 9 ma.).—*T. Leucutia.*

Schall, W. E. A two-valve transformer unit for diagnosis and therapy. *Brit. J. Radiol.*, Dec., 1931, *4*, 711–714.

The apparatus is a combination of the ordinary straight forward single valve unit with a split transformer circuit using two valves. Its purpose is to give reasonably high kilovoltage (up to 150) for therapy and high milliamperage (up to 250) for diagnosis. The diagrams of the construction are briefly discussed.—*T. Leucutia.*

Reisner, Alfred. Erythemversuche mit Grenzstrahlung. (Erythema production experiments with borderline rays.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Jan., 1932, *45*, 74–77.

The borderline rays produce an erythema of wavy character similar to that obtained with other rays. The peak of the erythema lies at a point which is twice that of the hard roentgen rays. A large dose produces marked inflammation of the skin, reaching its peak within a few days and lasting for a long period. The early appearance of the reaction is similar to that of the ultraviolet erythema, whereas the protraction is more of the type observed with the roentgen rays. Small doses produce rather pronounced pigmentation which is always more pronounced than that observed with roentgen and ultraviolet rays. An epilation was never observed. The individual sensitivity is quite marked. The same degree of erythema was observed, for example, with 2,600 and 1,400 r.

The following procedure is followed in the treatment with borderline rays. An individual dose of 250 r is administered first; eight days later the reaction is studied and the further treatment guided accordingly. The superficial dermatoses are treated, as a rule, with small doses, whereas in nevus vasculosus, warts, etc., rather large doses are used, being always careful to protect the surrounding skin with a thick zinc paste or simple covering with towels.—*T. Leucutia.*

Jassinsky, Ing. Spannungsabfall im rotierenden Gleichrichter. (The drop of tension with rotating rectifier.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Dec., 1931, *44*, 770–777.

The author describes a method which permits the determination with the aid of an oscillograph of the drop in tension in mechanical rectification. In contradistinction to Varga (see this Journal, 1930, 23, 124) who made an error in his measurements, he found that the drop of tension does not depend on the voltage and intensity of current but on the size of the gap between the segments or brushes and the arm of the rectifier. With soft wire brushes, which reduce the gap to a minimum, the drop in the potential was the least (1 to 1.5 kv.), whereas with the cast copper brushes, owing to the greater gap, the drop was considerably larger (9 to 10 kv.). It is advised therefore that during continuous operation of a mechanically rectified machine the brushes be repeatedly inspected and approximated to eliminate the drop in the voltage.—*T. Leucutia.*

Forssell, Gösta. Sweden's anticancer campaign. *Acta radiol.*, 1931, *13*, 295–318.

Figures are given showing that cancer is constantly increasing in Sweden which means that the burden of caring for cancer patients becomes greater every year. Therefore it became necessary to establish as efficient and economical organization as possible for extending existing means of treatment and making them available to everyone. The anticancer campaign is carried on along two great main lines: practical

hospital treatment and research and instruction in regard to cancer, and its treatment. There has been an effort to fit the cancer campaign into the general medical and nursing work of the country and avoid isolation and consequent over-organization. The treatment of cancer has been incorporated in the country's public hospital system and is carried on and paid for on the same principles as every other special medical treatment. Organizations for dealing with the surgical and radiological treatment of cancer have been established within the public nursing system.

The surgical treatment of cancer is performed in the general and special surgical clinics.

Radiotherapy for cancer has been centralized to a much greater degree than surgical treatment. Radiotherapeutic wards have been developed at three large central hospitals in Stockholm, Lund and Gothenburg and enlarged into central radiotherapeutic clinics for these sections of the country. These are equipped with personnel and material for roentgen and radium treatment and cooperate closely with the surgical clinics. Practically all the cases requiring radium or combined radium and surgical treatment are sent to these three clinics. Roentgen departments have been established in 26 of Sweden's 104 public hospitals in charge of medical officers specially trained in roentgenology. Cases requiring roentgen or combined roentgen-surgical treatment are sent to these hospitals.

Sweden has no special organization for following up cancer patients. This work is in the hands of the general practitioners and the outpatient departments of the hospitals. Means for transporting the patients quickly to the central radiotherapeutic institutions and paying their traveling expenses are provided at the central radiotherapeutic clinics. There are special departments at these clinics for controlling the treatment and looking after the patients during and after treatment, as well as social service workers and a public organization for statistical control of radiotherapy for cancer. Unfortunately no nursing service is provided for patients who are too far advanced to be given surgical or roentgen therapy. An organization for the care of these patients must be established.

Research in the radiotherapy of cancer is chiefly confined to the special radiotherapeutic clinics. The universities have arranged for the teaching of radiotherapy by organizing courses of instruction and by training radiologists and nurses at the special radiotherapeutic clinics of the universities.—*Audrey G. Morgan.*

Holfelder, Hans. Comparison of medical, surgical, and radiological conceptions in relation of the treatment of disease. *Brit. J. Radiol.*, Jan., 1932, *5*, 39–56.

This article represents the 12th Mackenzie Davidson Memorial Lecture. As the title indicates, the author considers the relative contribution of the medical, surgical and radiological man to the welfare of the patient, giving in a unique and very convincing way his conceptions of the status of these three men in the hospital. Thus he states: Everybody admires the skill of the surgeon, he is the great hero of the hospital, he is the most active personality, he is not the man of hesitation but of quick action who is always accustomed to see quick and prompt results. The internist, in contradistinction, focuses his attention upon every small symptom and sign, he is not a very quick acting man but his conceptions are much more contemplative. He observes the diseased patient very critically by means of very sensitive methods, therefore he is never satisfied with the diagnosis drawn from the synthesis of only symptoms of the disease but tries always to add other features of the special case in order to assure or to correct his first diagnosis. The roentgenologist, until now, was considered as merely a child but the child has meanwhile grown to manhood, having inherited the best gifts of its parents. The parents therefore should realize that the child now deserves an autonomous place next to them, equal in rank and right. For this reason the author advises that especially in radiation therapy, separate sections be established in the hospital under the direct leadership of the roentgenologist. Radiation therapy has become an essential part of the clinical method and requires urgently all clinical facilities. The University Roentgen Institute of Frankfurt, for example, takes full charge of its own ward with 50 beds. It is also very important that the actual treatment be carried out by competent roentgenologists. A careful planning out and application of every single roentgen-ray beam is one of the supreme and most important duties of the modern radiologist and determines the result of the

therapy just as the exact wielding of the knife determines the result of surgical operation.—*T. Leucutia.*

Mottram, J. C. Some blood examinations of x-ray workers. *Brit. J. Radiol.*, Feb., 1932, *5*, 156–158.

The author examined the blood picture of 30 radiologists and checked the findings against those of 26 hospital workers not exposed to roentgen rays. The blood counts are included in the form of a table. It was concluded, as a whole, that the blood of the roentgen-ray workers had not been affected by their occupation. However, in the control group the total red cells showed a rather high count, in the region of 7,000,000 in 7 cases. If these are deducted from the table, the average red count of the roentgen-ray workers appears higher as compared with the rest of the controls. This shift to the high side has been described by other observers as the earliest change in the blood of roentgen-ray workers, suggesting stimulation of the formation of the red cells. The distribution in white cells showed nothing in particular except in one case in which the count was as low as 3,000. This case will be observed further. —*T. Leucutia.*

Anderson, B. W. The use of x-rays in the study of pearls. *Brit. J. Radiol.*, Jan., 1932, *5*, 57–64.

This article deals with the x-ray analysis of cultured and genuine pearls, giving a brief description of the methods which are used and of the apparatus necessary for the examination. A plate is included illustrating patterns of pearls and of the calcite and aragonite which are the two calcium carbonate forms accounting for approximately 92 per cent of the pearls (the remainder consisting mainly of the protein conchyolin and water). The method is of value also in certain gem stones forming a sort of a final court of appeal which takes the place of the destructive methods of chemical analysis.—*T. Leucutia.*

Walmsley, H. P. A cabinet for the storage of radium needles. *Brit. J. Radiol.*, Nov., 1931, *4*, 608–610.

This article is a description of a cabinet constructed for the Manchester Radium Institute for storing radium needles. The cabinet is so devised that a stock of 700 needles containing approximately 2 grams of radium is stored. The cabinet consists of 20 drawers, each 16½ inches long and 1½ inches square in cross section. They are arranged in five rows of four and are carried in compartments in a gunmetal casting of ⅛ inch in wall thickness. Each drawer is filled to the top with lead, with the exception of a central wedge-shaped cavity 2½ inches long at the bottom, in which a loose lead block containing the needles is placed. The manner of drilling the loose blocks depends on the size of the needles they are to hold. Diagrams are included to show the design. The advantage of the cabinet is, in addition to the protection it affords, that it takes only ten to fifteen minutes to check the contents.—*T. Leucutia.*

Hirschberg, F. Le wagon radiologique des chemins de fer du Nord. (Radiologic car of the Northern Railway.) *J. de radiol. et d'électrol.*, Aug., 1931, *15*, 451–454.

Since tuberculosis has lately made great ravages among the employees of the Northern Railway of France, the Company constructed an ambulatory roentgen-ray division which performs periodic examinations within the territory of the railway. The plans of the two pullman cars, arranged for this purpose, are discussed and illustrated with diagrams and photographs. From November, 1930, to June 1931, 1,322 examinations were made, the cars having travelled more than 1,400 kilometers. The arrangement has proved very satisfactory. —*T. Leucutia.*

Barclay, A. E. Der normale Schlingmechanismus. (The normal mechanism of swallowing.) *Acta radiol.*, May 15, 1932, *13*, 91–109.

The author discusses the normal mechanism of swallowing. He holds that the bolus is carried from the back of the tongue to the level of the clavicle largely by negative pressure. The negative pressure in the pharynx is brought about by the combined action of raising the larynx and a backward movement of the tongue so that the pharyngeal space is completely obliterated for a fraction of a second. With mouth, nose and larynx closed, the reopening of the pharynx produces a negative pressure that is largely responsible for the act of swallowing. Except for fluids gravity plays a very minor part in normal swallowing. The larynx is cut off during the act of swallowing by the laryngeal pharynx being dragged up behind the larynx into contact with the epiglot-

tis, probably about a quarter of an inch below the tip of the epiglottis.

The phases in the process of swallowing are: (1) The mouth and nose are closed. (2) The larynx is raised and closed and its upper part is obliterated by the back of the tongue. (3) The pharyngeal space is obliterated by raising the larynx and retracting the tongue. The posterior wall of the pharynx does not come forward; the pharynx is not constricted but is compressed from before backward against the vertebrae. (4) The pharynx is opened and with the other three openings closed a negative pressure is brought about by lowering the larynx and a forward movement of the tongue. (5) During this movement the laryngeal pharynx still remains high up in close contact with the epiglottis. Its orifice is wide open. (6) The bolus slips over the back of the tongue. (7) Food is sucked into the open mouth of the laryngeal pharynx which, as the bolus passes into it, drops from the epiglottis down to its normal position, opening up the larynx after the bolus has passed. (8) The food is probably carried some distance down the esophagus by suction. —*Audrey G. Morgan.*

Wucherpfennig, V. Zur Verteilung der Roentgenstrahlen in der Haut. (The distribution of roentgen rays in the skin.) *Strahlentherapie*, 1931, *42*, 544–550.

Since no reliable determinations of the distribution of roentgen rays within the skin by means of small ionization chambers have been reported, the author calculates this distribution, using absorption values obtained in water and aluminum by Allen, Richtmyer and others. From the absorption in aluminum and water the absorption in tissue is obtained. Those points in the tissue which obtain 90 per cent, 80 per cent, etc., of the surface energy are called "relative depths" and they are illustrated on a schematic diagram of the skin for various half-value layers of aluminum. The accuracy of this method is limited and direct measurements of the intensity distribution within the skin are highly desirable.—*Otto Glasser.*

Ponzio, Mario. L'Istituto Radiologico Mauriziano di Torino. (The Mauriziano Radiological Institute at Turin.) *Radiol. med.*, Feb., 1932, *19*, 166–173.

This new radiological institute was opened on August 31, 1931. It is equipped with the most thoroughly modern apparatus for roentgen diagnosis and roentgen and radium treatment. It also has a laboratory for physical and biological research, a section for physiotherapy and a good roentgen library. The apparatus in use and the arrangement of the rooms are described in detail and illustrated.—*Audrey G. Morgan.*

Vanoni, Enzo Pugno. La protezione contro i pericolo da élettricita e da raggi in radiologia. (Protection against electricity and rays in radiology.) *Radiol. med.*, March, 1932, *19*, 328–343.

The International Congress of Radiology in Paris in 1931 adopted the following rules as international norms for protection. Of course they are only suggestions for adoption by the different countries.

Workers with roentgen rays should not work more than seven hours a day and not more than five days a week and the free days should be passed as far as possible out of doors. They should have not less than four weeks' vacation a year, preferably consecutive. On entrance into the service and thereafter twice a year they should have a systematic physical examination and blood examination.

The roentgen-ray section should not be below ground level. All rooms, including the dark room, should be provided with windows giving plenty of light and air. All should be provided with adequate aspirating ventilators, capable of renewing the air not less than ten times an hour. All the rooms should have light colored walls. The best temperature for a roentgen room is 18° C. All rooms should be large enough for convenient installation of the apparatus—the minimum area should be 25 square meters for the roentgen room and 10 square meters for the dark room. The height of the room should not be less than 3.5 meters. If possible the apparatus for generating the high tension current should be kept in a separate room from the tube.

Roentgen-ray workers should not expose themselves unnecessarily to the direct action of the rays; they should stay as far away from the tube as possible. The tube should be surrounded as completely as possible by a protecting material equivalent to a certain thickness of lead; the thickness necessary for different strengths of current is given. In diagnostic work the operator should be protected from diffuse rays by a screen equivalent to 1 mm.

lead. In treatment the operator should preferably be outside the roentgen room behind a protective screen equivalent to 2 mm. lead. This thickness should be correspondingly increased if the protection of the tube is less than that specified above. Screen examinations should be carried out as rapidly as possible, with as small a field as possible and the lowest possible tension. Palpation with the hands should be limited as much as possible. The lead-glass of the fluorescent screen should have the same protection as indicated above for the tube. In diagnosis adequate protection should be provided for the operator against the diffuse radiation of the patient. The inspection windows in walls or screens should have protection as adequate as other parts of the wall or screen. Protective measures should be adopted against the possible omission of metallic filters in roentgen therapy. Gloves should have a protection equivalent to not less than $\frac{1}{3}$ mm. of lead, covering both the back of the hand and the palm and including the fingers and the wrist. Aprons should have a protection equivalent to 0.5 mm. lead.

To protect against electricity the pavement should be of isolating material, such as wood, rubber or linoleum. The high tension wires should be not less than 3 meters above the floor. They should be made of metal wires of considerable size or some other conductor which will not produce a corona effect. The connecting wires should be made in such a way as not to produce a corona effect. If possible the high tension circuit should be completely enclosed in conducting screens connected with the ground. If there is no special reason to the contrary the metal parts of the apparatus should be connected with the ground. Bipolar interruptors should be used which will interrupt both poles at once. When more than one apparatus is supplied by the same generator suitable deviators should be used. A kilovolt-meter should be installed for measuring the tension. Special precautions should be used if anesthetics are being used at the same time as roentgen rays.

The use of non-inflammable films is recommended. If inflammable films are used special precautions should be used, but it is difficult to give details because the laws for fire protection differ in different countries. Large amounts of films should be kept in separate buildings in isolated places.

To protect the hands against beta rays, radium should be handled with forceps with long handles and should be carried from one place to another in boxes protected on all sides with at least 1 mm. lead. All manipulations should be carried out as rapidly as possible. When not in use radium should be kept in a safe as far as possible from the personnel. The radium tubes should be placed in the safe in cells with lead walls varying in thickness for the amount of radium. The thicknesses for various amounts are given. The tubes should be mounted in a special place where the workers remain only while at work. To protect the body against penetrating gamma rays a screen should be used equivalent to not less than 2.5 mm. lead and the operator should not remain near the radium any longer than necessary. The room for measuring radium should be a separate one and the radium should be kept there only while it is being measured. Nurses and attendants should not remain where a patient is being treated with more than half a gram of radium. All work that is not specialized should be done by temporary workers who should not remain at it more than six months. Care should be taken in sending radium by mail. Small amounts should be protected with not less than 3 mm. lead. Large amounts should be carried by hand, suitably protected.

Persons using radiations should be protected against both beta and gamma rays. The emanations should be manipulated as far as possible while they are inactive. Any escape of emanations should be avoided and the place where they are used should be provided with an aspirator. If the emanations are apt to come into contact with the fingers thick rubber gloves should be used to prevent the formation of a deposit on the skin. The protective measures indicated above for salts of radium should also be used. The pumps should be in a separate building connected by tubes with the place where the radium solution is. The radium solution should be strongly screened to protect those who work near it. It is best to keep it in boxes lined with lead of the thickness given above for radium salts.

These rules are probably not final but the author recommends their adoption in Italy in place of the rules adopted there in 1925 which are insufficient.—*Audrey G. Morgan.*

Desjardins, Arthur U. The postgraduate and graduate teaching of radiology. *J. Am. M. Ass.*, March 19, 1932, *98*, 933–936.

A well-considered scheme of instruction should provide for a short postgraduate course of a few weeks for physicians in general who wish to be informed of newer methods, as well as radiologists who wish to keep abreast of new developments. Opposition to this kind of course, based on the belief that it would encourage physicians to employ radiologic measures without sufficient preparation, is without adequate foundation in fact. Radiology as a specialty would benefit by such dissemination of knowledge as have other specialties.

A second or comprehensive graduate course for physicians who desire to qualify as specialists in radiology should be developed on broadest possible lines. A three year course should include first, a half year of concentrated training in anatomy, physiology, pathologic anatomy, and microscopic pathology, with which subjects radiologists cannot be too familiar. Next should follow a half year given to radiologic physics with both didactic lectures and laboratory exercises. The second year of the course should deal with diagnostic roentgenology. Under careful supervision the student should be required to perform all technical procedures and make interpretations. The third year should be given over to therapeutic radiology, including roentgen rays, radium and ultraviolet radiation with equal time devoted to roentgen-ray and radium therapy, although the latter has a narrower scope. Finally, each graduate student should be required to undertake a piece of research on some phase of diagnostic or therapeutic radiology and prepare a report or thesis based thereon.—*E. W. Hall.*

Pancoast, Henry K. Teaching of radiology to undergraduate students. *J. Am. M. Ass.*, March 19, 1932, *98*, 938–943.

Undergraduates should be given instruction in radiology so that as internes and physicians they may be able to appreciate roentgenograms, understand the numerous references to radiology in literature, and know the value and limitations of radiology in its applications to various diseases and various medical specialties. They should be impressed with the importance of radiologic interpretation by competent and honest specialists to avoid their support and toleration of unscrupulous physicians and laymen who commercialize radiology.

Didactic instruction should be avoided except where necessary. However, a short didactic course in physics should be the first part of the training. Anatomy, physiology and pathology should be taught in relation to roentgenography, incorporating roentgenologic demonstrations in the regular lectures. All preclinical as well as subsequent instruction should be under the direction of the professor of radiology. In the third and fourth years separate lectures and demonstrations are advisable with review of principles of the basic subjects. Small groups are preferable to large groups. Radiation therapy should be taught through the agency of cancer clinic groups.—*E. W. Hall.*

Russ, Sidney. Nature of the action of radium and x rays upon malignant growths. *Lancet*, April 23, 1932, *1*, 874–876.

The various theories of the nature of the action of gamma rays of radium and roentgen rays upon malignant growths are reviewed. Altogether the evidence seems to show that the action of these rays is partly a direct one and partly an indirect one. In an evaluation of the various actions of these radiations, bearing in mind their order of appearance in the scale of quality—how some of the vital functions of living tissues are put out of action by a quantity of radiation which has but a trifling action upon their other processes—perhaps the most important classes of action would be determined as: (1) Those which interfere with or disorganize the delicate processes involved in the division and maturing of cells; (2) those which determine the release into the tissues and into the circulation of the products of cells, normal as well as malignant, whose destruction is caused by the rays, and (3) those which produce changes not only in the content and production of the blood, but also in its power of dealing with infection.—*W. R. Brooksher, Jr.*

Meyer, Heinz Theodor. Über Wellenlängenabhängigkeit keliner Ionisationskammern. (The wave length dependence of the small ionization chambers.) *Strahlentherapie*, 1931, *40*, 576–589.

The author investigated the dependence upon wave length of a large series of thimble ionization chambers. Various substances (Si, Al_2O_3, MgO and BeO) were added to graphite chambers, and measurements of the ionization current in these chambers for rays of a half value layer of 0.15–2 mm. of copper were made. The percentage weight of the various sub-

stances which were added to the graphite in order to obtain ionization currents which were independent of the wave lengths, was determined. The results obtained permit drawing conclusions as to the accuracy of the Fricke-Glasser method of the small air chamber. The author finds that, strictly speaking, the important factor is not the effective atomic number, according to Fricke and Glasser, but the electron density in the chamber material. A large number of experiments, tables and curves proving these statements are given.—*Otto Glasser.*

Benner, Sven. On secondary β-rays from the surface of radium containers. *Acta radiol.*, Sept. 30, 1931, *12*, 401–412.

The secondary β-irradiation from different substances has been examined by means of an ionization chamber, using a magnetic field to deflect the β-rays. In agreement with other authors it is found that the secondary β-radiation, as a function of atomic weight, has a broad minimum, approximately between 26 and 50, the atomic weights of iron and tin. Its great importance in treatment is pointed out and a palladium alloy is proposed as a suitable material for radium needles. For other types of radium applicators nickel or rustless steel is recommended as secondary filters.—*Audrey G. Morgan.*

Failla, G., and Henshaw, P. S. The relative biological effectiveness of x-rays and gamma rays. *Radiology*, July, 1931, *17*, 1–43.

A direct method of measuring gamma rays in roentgens is described. In principle, it is the same as the one ordinarily used for standardization measurements with roentgen rays. With the method and apparatus used by the authors the gamma-ray emission of 1 gram of radium was found to be 36 r/min. at a distance of 1 cm. Experiments are described which make possible the direct comparison of biological effects produced by roentgen and gamma rays in five different tissues. The experimental results show that the quantity of radiation required to produce a certain degree of effect in a given tissue depends on the quality of the radiation. Therefore, in radiation therapy the radiosensitivity of all tissues in the irradiated volume should be known for each quality of radiation employed.—*J. D. Camp.*

Taylor, Lauriston S. International comparison of x-ray standards. *Radiology*, Jan., 1932, *18*, 99–114.

Direct comparisons between the roentgen ionization standards of the United States, England, Germany, and France, are described. The small guarded field ionization chamber was used as the working standard and transported to the several laboratories. Careful check of the instrument calibration at each laboratory showed no change due to transportation. Complete corrections were made for air absorption, differences in current measurements, and differences between chamber diaphragms. The final agreement between the United States, English, and German standards was ±0.5 per cent. The ratio between the international roentgen and Solomon's unit for hard radiation (half-value larger greater than 0.75 mm. Cu) was 2.29. As a result of diaphragm discrepancies found in England, a study of diaphragm measurements was made. It was found that lead diaphragms tended to warp with age, rendering difficult an accurate determination of their area. Plug gauge and micrometer microscope measurements were averaged for the final results.—*Ellsworth Johnson.*

Mottram, J. C., and Eidinow, Albert. On the effect of anaemia on the reactions of the skin and of tumours to radium exposure. *Brit. J. Surg.*, Jan., 1932, *19*, 481–487.

An effort was made to study variations in skin reactions from a radium plaque produced in rats following an artificially induced anemia. A standard erythema dose was applied to control animals and to a group in which 1 to 5 c.c. of blood had been removed from the heart The skin reactions produced by both beta and gamma radiation were definitely less severe in the anemic animals.

A second series of experiments was carried out by using rats inoculated with small pieces of Jensen's rat sarcoma in both flanks. One tumor was treated with beta rays before the bleeding process and the other afterwards, using the same dose each time. During the period of observation, it was noted that the tumors treated after the induction of anemia grew more rapidly than the controls. The authors conclude that tumors in anemic individuals do not respond well to irradiation and advise that a special effort be made to combat

anemia in cancer patients before treatment is administered.—*C. L. Martin.*

Lauritsen, C. C. Spectrum of the radiation from a high potential x-ray tube. *Radiology*, July, 1931, *17*, 131–135.

A spectrograph of the Seemann type was constructed for the purpose of investigating the radiation from the high potential roentgen tube at the California Institute of Technology. A typical spectrogram obtained with 600 kv. on the tube is presented. The photometer record shows a continuous spectrum with its maximum intensity to about 200 kv. and a short wave length limit in the neighborhood of 600 kv. The range covered is roughly from 100 to 20 x-units. It is proposed to use the apparatus for determining absorption coefficients by photographing the spectrum of radiation which has passed through an absorbing screen. No anomalies of any kind have been observed so far.—*J. D. Camp.*

Clark, G. L., and Fitch, K. R. Chemical effects of x-rays upon some aromatic colors and dyes. *Radiology*, August, 1931, *17*, 285–293.

A large number of aromatic colors and dyes were exposed to roentgen rays under the same condition of irradiation, to determine, if possible, some of the general types of structure giving good visible color changes. Some of those showing the most promise from the point of view of stability and degree of color change are the triphenyl methane, alizarin, thrazine, and indigo types. Experiments were started upon simple molecules with but one or two reactive groups and were carried through to more complicated structures.

Substituent non-metallic groups may change the susceptibility of the labile bond in a simple aromatic structure toward roentgen exposure. Metallic salts and complexes of an aromatic color may give color changes upon exposure to roentgen rays much different from that of the parent dye, thus vastly increasing the number of possibilities of these changes.

Any type of color changes desired, such as color increases, decreases, etc., can be obtained by proper selection of the colors. From the known chemical and physical properties of these compounds, many roentgen-ray color changes can be predicted in advance.

The magnitude of the field is such that in all probability the color most suitable as an intensity indicator has not yet been found. The roentgen ray in particular and radiation in general furnish one of the most sensitive tools known for the examination of complicated reactions.—*J. D. Camp.*

Taylor, Lauriston S. Accurate measurement of small electric charges by a null method. *Radiology*, August, 1931, *17*, 294–303.

In the use of an electrostatic system for measuring charges and currents, it is necessary to know the electrostatic capacity of the system. For small capacities the error in this measurement may easily be 1 per cent. There is here described a new method for calibrating a null system in such a manner that the capacity of the leads does not enter and which, therefore, permits a reduction in the calibration error to one-tenth. When a system is once calibrated in the manner described, any unknown capacity whatever may be added to the leads without affecting the measurement of the desired quantities. Expressions are given for the sensitivity of the system in terms of readily measured quantities. Applications to the measurements of current, charge, and capacity are discussed.—*J. D. Camp.*

Profitlich, P. Über den Spannungsverlust im Scheibengleichrichter. (On the loss of tension in disc rectifier.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, April, 1931, *43*, 498–501.

The author, by making use of Küstner's ionization apparatus, determined the drop in the high tension voltage caused by disc rectification, and found that the increase in the secondary voltage (40, 50, 60 and 70 kv. max.) had no effect when the milliamperage remained constant, the drop in the voltage being always the same (7 kv.), whereas the increase in the milliamperage (1, 5, 15, 30 and 60 ma.) with constant high tension voltage produced a decrease in the loss of the rectification voltage. This latter is contrary to what one would expect and is the result no doubt of the decrease in the resistance due to the transformation of the sparks at the rectifying brushes into arc flames.—*T. Leucutia.*

Weber, E., and Russo, C. Über die Abhängigkeit der Expositionszeit von der Spannung. (On the dependence of the exposure time

on the tension.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Feb., 1931, *43*, 226–231.

The present article was written in 1927 but because of the loss of interest in the subject it was not published until now. The stimulus for its present publication was furnished by a recent communication of Profitlich stating that the fourth power law does not always apply to the calculation of the exposure time. The authors, after minute investigations of the dependence of the exposure time on the variation of the voltage, have found that the following formula is of value:

$$t_2' = t_1' \frac{ma_1\, kv_1 x}{ma_2\, kv_2 x}$$

in which t_1' is the known time of exposure, t_2' the time of exposure to be determined, ma_1 the milliamperage of the current in the known exposure time, ma_2 the milliamperage of the current in the exposure time to be determined, kv_1 the tension of the tube in kilovolts in the known exposure time, kv_2 the tension of the tube in kilovolts in the exposure time to be determined and x the power exponent. This latter is determined by making two roentgenograms of the same object under identical conditions with two extreme voltages, being careful to obtain an identical optimum blackening of the soft parts on the film. The power exponent, in other words, the power to which the voltage has to be raised, is then figured as follows:

$$x = \frac{\log t_2 - \log t_1}{\log kv_1 - \log kv_2}$$

in which t_1 is the exposure time in seconds in the first roentgenogram, t_2 the exposure time in seconds in the second roentgenogram, kv_1 the tension of the tube in kilovolts of the first roentgenogram, and kv_2 the tension of the tube in kilovolts of the second roentgenogram.

The formula can be used: (1) for the calculation of the exposure time in case the milliamperage or the voltage is changed, everything else remaining the same, and (2) for the calculation of the required load of the apparatus and tube in a given exposure time and object type.—*T. Leucutia.*

Dognon, A., and Massa, J. La technique et l'action biologique des rayons X de très grande longueur d'onde. (The technique and biologic action of roentgen rays of very long wave length). *J. de radiol. et d'électrol.*, Jan., 1931, *15*, 22–32.

The authors, in experimenting with the Dauvillier tube for more than a year, found that this tube has certain disadvantages which makes a regular service impracticable. One of these is that the cellophan window often breaks due to the excessive heat produced by the bombardment of the electrons (or of the ions of the residual gas). Other disadvantages are in connection with the mounting of the tube, the change of filters and the pumping system.

The authors have made several modifications which render the use of the tube more simple and practicable. These modifications which apply chiefly to the construction of the tube, to the pumping system and to the source of energization (constant tension generator) are described in detail and illustrated with diagrams and photographs. The breaking down of the window was eliminated by supplying the lower part of the tube with a cooling device.

After discussing the best method of measurement, the dependence of the output of the tube on the voltage and thickness of the cellophan window, the decrease of the intensity with increasing distance, the action on the epidermis, the threshold erythema, the question of penetration and the effect of superimposition of the doses, the authors arrive at the conclusion that although the recent modifications have made the application of roentgen rays of very long wave length a rather simple procedure, the therapeutic value still remains limited. The results obtained are as yet far from satisfactory, despite the fact that two good qualities of the rays must be recognized: (1) enormous doses may be administered over the epidermis without provoking the least permanent injury and (2) the intensity and extremely long duration of the erythema provoked, as well as the possibility of re-application permit their use for ong periods.—*T. Leucutia.*

Chantraine, Heinrich, and Profitlich, Paul. Über gleichgerichteten Wechselstrom, gleichgerichteten Drehstrom und reine Gleichspannung. (On the rectified alternating current, rectified rotating current and true constant tension.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, June, 1931, *43*, 746–757.

The authors compared the radiation output of the valve rectified alternating and rotating current machines with that of the constant tension machine by making use chiefly of the

photometric and, in a few instances, of the ionometric method. The radiation was filtered with 7 mm. Al which corresponds to 7 cm. water thickness or the thorax of a medium developed individual.

It was found that by using 38 kv. with constant milliamperage and 7 mm. Al filter, an exposure 3.5 times longer was required with the rectified alternating current to obtain the same degree of blackening of the film than with a constant tension, this indicating that the radiation output at 38 kv. constant tension was 3.5 times greater than at 38 kv. max. rectified alternating current. At the same time, the radiation produced by the constant tension was somewhat harder, the rays obtained with 38 kv. being equal to the rays produced by 39 kv. max. rectified alternating current. By reducing the 39 kv. max. (which yields with 7 mm. Al an amount of radiation 33 per cent higher than at 38 kv. max.) to 38 kv. max. and by deducting the 33 per cent increase in the radiation output due to the higher voltage, the figure of 2.6 is obtained, that is, the increase in the radiation output of the constant tension machine, as compared with the rectified alternating current machine, will drop from 3.5 to 2.6 (at 38 kv.). If the comparison is made at a higher voltage, as, for example, 700 kv., the increase in the radiation output of the constant tension machine will be only 2.1 times greater. This figure, by again deducting the difference resulting from the equalization of the hardness of the rays (70 kv. max. of the rectified alternating current corresponding to 64 kv. constant tension with a difference of 40 per cent in the output) is further reduced to 1.54. Finally, if one takes into consideration that the constant tension generally yields an energy 1.4 times greater than the rectified alternating current, an improvement of only 10 per cent is obtained.

In comparing the rectified rotating current with the constant tension current it was found that the six phase current fairly resembles the constant tension current, whereas the three phase current (which is the one used in several machines) yields after eliminating all sources of error an improvement which is only half of that of the constant tension current. In connection with this, the author discusses the value of the Philips condenser apparatus (which, as is known, is a rectified rotating current machine) for roentgenography of the chest.

The amount of radiation delivered to the skin of the back in case of roentgenography of the lung with true constant tension is 0.9 to 1.1 r.

With rectified alternating current, the output of the gas containing tubes is nearly 100 times greater than the output of the gas free tubes, assuming that the same kind of radiation with identical milliamperage and 7 mm. Al filter was used. This increase is due to the flatter and broader peak of the tension with gas containing tube.—*T. Leucutia.*

Sievert, Rolf M., and Olsson, Ernst. Zur Bestimmung des Mesothor und Radiothorgehalts von eingekapselten Radiumpräparaten. (Determining the mesothorium and radiothorium content of encapsulated radium preparations.) *Acta radiol.*, Apr. 15, 1931, *12*, 121–134.

The authors describe experiments carried out with a gamma-ray absorption apparatus made on the principles described by Bothe in *Ztschr. f. Physik*, 1924, *24*, 10. They discuss the possibility of determining whether radiothorium or mesothorium is contained in capsulated preparations and show that this method, which is based on the variation of the radium equivalent with increasing lead filtration, is suitable for the following purposes: (1) determination of the proportion of mesothorium in freshly made radium-mesothorium preparations; (2) determination of the amounts of mesothorium and radiothorium present provided the proportion of radium is known, and in that case it is also possible to determine the approximate age of the preparation; (3) determination of the proportion of radium when the proportion of radiothorium to mesothorium is known from the age of the preparation.

A large number of preparations practically free of radioactive impurities were examined to determine the exact margin of error of the experiments. The curves for mesothorium and radiothorium respectively were obtained by measurements with mesothorium free of radiothorium and with pure radiothorium. With the aid of these curves the radium equivalent of any test specimen can be determined and the radium-equivalence of the radioactive impurities present can be calculated within a few per cent. The accuracy of the measurements is to a great extent dependent on the age of the preparations but as a general rule the method

is reliable for determining even considerable amounts of mesothorium and radiothorium.—*Audrey G. Morgan.*

Sievert, Rolf M. A new method for determining the intensity of γ- and x-ray irradiation. *Acta radiol.*, Apr. 15, 1931, 12, 190–199.

This is a preliminary announcement of a new method of measuring radium and roentgen radiation. It is possible by means of it to make accurate and simple measurements of the distribution of radiation in the human body without the necessity of installing delicate measuring instruments in the operating room. The method is based on the ionization effect in a chamber of large capacity relative to its air volume. A charged, closed chamber without connecting wires is exposed for a certain time to the radiation to be examined, and the consequent loss of potential is then determined by placing the chamber on an electrometer of comparatively low sensitiveness (a Wulf double-string instrument). Corrected by means of the calibration curve of the instrument, the deflection furnishes a relative measure of the intensity; when this is multiplied by a constant determined experimentally for each chamber, the result may be expressed in absolute units.

Two chambers have been examined, the smallest of which is a ball of very light material; it is made of magnesium and is 14 mm. in diameter. As this chamber proved very reliable, similar chambers are being made, the smallest of which are 12 mm. long and 5 mm. in diameter or 20 mm. long and 3 mm. in diameter. The latter type is provided with a sharp point for interstitial application like radium needles.

The author thinks the method very promising and will in the near future publish further detailed examinations.—*Audrey G. Morgan.*

Reuterwall, O. The work of the Radiumhemmet's department for tumor pathology. *Acta radiol.*, 1932, *13*, 395–403.

The cases referred to a special clinic are apt to be particularly difficult ones requiring the judgment of a clinical pathologist in their interpretation. The Radiumhemmet has had a pathological department since 1923 and the author reviews the work of this department. The work of the department includes microscopic diagnosis and prognosis, the scientific analysis of material treated by irradiation and research in the fields of tumor and irradiation pathology. The department has two special tasks to accomplish: the refinement of diagnosis from specimens obtained by biopsy and the establishment of a basis for diagnosis in material treated by irradiation. The specimens obtained by biopsy are often almost infinitesimally small and diagnosis from them very difficult. Diagnosis is also very difficult from tissue that has been subjected to irradiation. The study that has been given to changes caused by irradiation has been an effort to determine their causes rather than to classify the varieties in the picture and determine their relation to the original growth.

One important fact brought out by the department is that electrocoagulated tissue can be used for microscopic diagnosis. They have been making a special study of cancers of the breast, and the so-called mastitis or fibroadenomas, carcinomas of the uterus and papillomatous tumors of the ovary.—*Audrey G. Morgan.*

Vischia, Quintino. Il trauma nella genesi dei tumori. (Trauma in the genesis of tumors.) *Radiol. med.*, June, 1932, *19*, 551–557.

There is still active discussion in regard to the relationship between trauma and tumor, which is of great medicolegal importance. The author reviews the cases of tumor caused by trauma which have been reported in the literature and reports one of his own in which he thinks the tumor was caused by trauma.

The patient was a woman of twenty-seven who had always been well. She had had 4 pregnancies, one of them interrupted by abortion in the third month. The three children are living and well. Two years ago she fell from a height and struck on her left leg. She had pain in the upper third of the leg and redness and swelling of its anterior surface. She soon recovered but about a week before her admission to the hospital suffered another trauma in the same region, followed by pain and such great swelling that it was hard for her to walk. She had no fever and her Wassermann reaction was negative. There was a hard painful swelling of the anterolateral surface of the left leg. Roentgen examination in the anteroposterior and lateral directions showed an intensely opaque shadow about the size of a hen's egg involving the region of the lateral condyle of the tibia and all of the proxi-

mal epiphysis of the fibula. The head of the fibula showed a vertical fracture line. Roentgen examination of the thorax for metastases did not show any pathological condition.

As the patient refused operation the tumor was removed and the bone curetted but recurrence in the knee necessjtated amputation. Histological examination showed that the tumor was a fibrosarcoma.

The author thinks the evidence was sufficient to show that the tumor was caused by the trauma. He does not discuss the possibility of a pre-existing tumor being awakened into activity by the trauma which is a prominent point in many of the discussions on this subject.—*Audrey G. Morgan.*

Rémy-Roux. Sur un cas de granulations cal caires sous-cutanées (contribution au pronostic). (A case of subcutaneous calcareous granulations; contribution to the prognosis.) *Bull. et mém. Soc. de radiol. méd. de France*, July, 1932, *20*, 437–440.

The author recently had the opportunity of re-examining a girl whom he saw two years previously at which time roentgenograms demonstrated subcutaneous calcareous deposits in several parts of the body. Since then the condition has made a very rapid deterioration, the patient being at the present time in quite a precarious state. Calcareous deposits are demonstrated now in the subcutaneous tissue localized throughout the body and invading part of the muscles. The conclusion is reached that this condition is more serious than hitherto assumed. The progressive calcification which started in the subcutaneous tissues had led to a state of total invalidism as soon as the muscles became involved and at the present time the life of the patient is in danger.—*T. Leucutia.*

Doumer, E. Traitement des radiodermites par l'acide elaïerinique. (Treatment of radiodermatitis by elaidic acid.) *Bull. et mém. Soc. de radiol. méd. de France*, Dec., 1931, *19*, 498–502, also Jan., 1932, *20*, 22.

The author two years ago published in the *Gazette des Hôpitaux* a short article calling attention to the method of treatment which he had proposed for radiodermatitis about twenty-five years ago. He received numerous letters endorsing the method and therefore in the light of these new documents he now redescribes the procedure. It consists in the use of elaidic acid which is prepared from lamb fat and put on the market under the name of "lipol," being applied in the form of a salve. In case of acute radiodermatitis a healing is observed within a few months but in the chronic cases a more prolonged use is advisable. Two rather unusual cases in which good results were obtained are described in detail. The author also states that he himself developed a rather severe radiodermatitis which he treated in 1906 with lipol having obtained a good healing which has persisted since.

In the discussion which followed, Haret mentions that he used the preparation about two years ago for a chronic radiodermatitis with a deep ulcer of the right ring finger but that later an amputation had to be performed. More recently he applied it to an ulcer of the right index finger which has now persisted for about eight months. He observed some very good initial response but one month later the ulcer failed to entirely heal. He will continue its use, however.—*T. Leucutia.*

Baroni, V., and Comsia, O. Influenţa clorurei de magneziu asupra evoluţiei sarcomului experimental. (Influence of magnesium chloride on the evolution of experimental sarcoma.) *Cluj. med.*, Nov., 1932, *13*, 531–533.

It was observed since 1891 that very few cases of cancer occurred in Egypt. This unique phenomenon was explained on the ground that the soil of Egypt is very rich in magnesium salts which have an inhibiting effect on the development of cancer.

Several experiments were made recently in testing the effect of magnesium preparations on the growth of cancer. The authors experimented with a series of sarcomas in rats and arrived at the following conclusions: (1) Magnesium chloride has an inhibiting action on the growth of Jensen's sarcoma; (2) the healing effect of this salt is the greater, the less the virulence of the tumor; (3) large doses nearing the limit of toxicity are not as efficacious as smaller doses; (4) the best route of administration is the intraperitoneal one; (5) a preliminary magnesiumization of the animals increases the percentage of healings; (6) animals treated with insufficient doses of magnesium present an excessive growth of the tumor.—*T. Leucutia.*

Baroni, V., and Comsia, O. Influenţa clorurei de amoniu asupra evoluţiei sarcomului experimental. (Influence of ammonium chlo-

ride on the evolution of experimental sarcoma.) *Cluj. med.*, Dec., 1932, *13*, 590–592.

In a second series of experiments the authors tested the effect of ammonium chloride on the sarcoma of rats, arriving at the following conclusions: By injecting ammonium chloride intraperitoneally into rats with Jensen's sarcoma of average virulence a complete disappearance of the tumor is obtained in 60 per cent. It is probable that the slow action of the salt on the tumor leads to an ammoniumization of the system which in turn leads to disappearance of the sarcoma. In repeating the experiments with very virulent Jensen's sarcoma, which in the control animals produces a mortality of 100 per cent, a reduction of the tumor to half the size is observed in most instances but here the rapid disintegration of the tumor is followed by a mortal intoxication of the rats.

The authors express the opinion that the growth of the tumor in these experiments is influenced by the fact that the alkali reserve is lowered which indirectly through an unexplained mechanism leads to a permanent immunity. All animals once cured of their sarcoma by the injection of ammonium chloride remained later refractory to subsequent grafts with sarcoma.—*T. Leucutia.*

Picard, Eugene, and Liegeois. Epitheliomas pilaires. (Pileous epitheliomas.) *Cancer, Brux.*, 1931, *8*, 121–131.

Three cases of cutaneous cancers are described which because of their peculiar structures are considered as pileous epitheliomas. The clinical, as well as the anatomo-physiologic appearance, is discussed. Inasmuch as the microscopic sections contained islands of concentrically arranged basal cells with filamentous cells in the center, a picture usually observed in hair follicles, it was thought that the epitheliomas were of a pileous origin. In two of the cases pigment was included within the areas, which, however, must not be confused with pigment formations observed in nevo-carcinomas which are of a more serious prognosis. The treatment of choice is electrocoagulation with application of radium.—*T. Leucutia.*

Rees, W. J., and Clark, L. H. On the quality and significance of the scattered radiation produced in water subjected to beams of x-rays and gamma rays. *Brit. J. Radiol.*, May, 1932, *5*, 432–444.

This article deals with the experiments made for the study of the quality of radiation scattered by water in a vessel exposed to medium and penetrating roentgen rays and the gamma radiation from powerful radium sources. The procedure is described in detail. A copper ionization chamber was used which was found to be quite suitable for roentgen rays but no longer suited for the radium. As a whole, the conclusion is reached that no matter how penetrating the primary beam, multiple scattering will occur in the irradiated volume, resulting in the formation of much softer radiation which forms no inconsiderable portion of the total radiation traversing the medium.—*T. Leucutia.*

Lavedan, Jacques. Recherches sur les modifications du sang chez les malades traitées par les radiations pour cancer du col de l'utérus. (Researches on the modifications of the blood in patients treated by irradiations for cancer of the uterine cervix.) *Radiophys. et radiothérapie*, Volume 2, No. 4, 457–539.

The author carried out a series of investigations on the blood changes which are observed following radiation therapy for cancer of the cervix. In this article, after a detailed review of the literature on the subject, he presents the results of these investigations by citing each case individually. In 14 cases he used roentgen therapy alone, while in another 22 he employed curie therapy. Only non-cachectic patients were chosen, the presence of the carcinoma being verified histologically in every instance. The roentgen therapy consisted in the use of penetrating rays, whereas the curie therapy was carried out in a transcutaneous way with the technique employed at the Radium Institute of Paris in 1924, 1925 and 1926. From the point of view of blood changes the cases were divided into two groups: (*a*) those in which the modifications occurred between the beginning and the end or immediately following the end of one series of irradiations, and (*b*) those in which the modifications occurred between the beginning and the end or several days following the end of the entire series of irradiations constituting a radiotherapeutic treatment. In the first group it was found that an irradiation of sixty minutes' duration produced a leucopenia with lymphopenia which was rapidly followed by a polynuclear leucocytosis. At the same time there was a notable shortening in the time of coagulation. The modifications gradually de-

creased during subsequent irradiations, except for the leucopenia which reached its maximum following the second irradiation. In the second group the changes observed most frequently consisted in a moderate diminution of the hemoglobin and of the red blood cells, appearance of leucopenia with lymphopenia, monocytosis, and polynucleosis, which was, however, mostly relative. In anemic patients an increase of the red corpuscles was found due to arrest of the hemorrhages, whereas in cases with secondary infection a polynuclear leucocytosis was not infrequent. With the exception of this latter, all changes rapidly disappeared (within a maximum of two months) leaving no permanent alterations in spite of the magnitude of the doses used.

It is impossible to draw from this study conclusions concerning the prognostic indications, yet it appears that the appearance and persistence of a leucocytosis during the course of treatment, especially when associated with true polynucleosis, indicates a rather unfavorable condition, whereas the appearance of a marked lymphocytosis following irradiation constitutes a good sign, all patients showing this phenomenon having been cured.

All in all, the statistics of the cases treated in 1924, 1925 and 1926 for cancer of the uterine cervix at the Radium Institute of Paris prove that a high percentage of five-year cures may be obtained without impairment of the integrity of the blood.

A bibliography of 40 articles is appended.—*T. Leucutia.*

Borak, J. Über die epidermiolytische Bestrahlungsreaktion. (On the epidermiolytic irradiation reaction.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, April, 1932, *45*, 397–406.

The epidermiolytic reaction produced by irradiation was first described by Regaud and Nogier in 1913 and has been used since then under the term of radioepidermitis as a basis of biologic dosage at the Radium Institute of Paris. Coutard is to be credited for having introduced this biologic measure in roentgen therapy. The term epidermiolysis implies a reaction which leads to a destruction of the epidermis alone (and of the hair tissue) without producing a like injury to any other tissue. It develops within five weeks after the application of the irradiation and then it subsides, leading to complete restitution. Thus the reaction may be considered as a temporary and a completely reversible one. As is known, Coutard obtaind an epidermiolysis by giving a very large dose of roentgen rays in a fractionated and protracted way. The total dose in his series amounts to 5,000 r, which is spread over a period of three to five weeks. The onset of the reaction depends (1) on the amount of the fractionated dose; (2) on the amount of the total dose, and (3) on the continuity under which the radiation is given. There are also individual variations and there is a certain difference in the sensitivity of the various regions of the body, the neck appearing the most sensitive of all. This, in the author's estimation, is of importance because Coutard figured the minimum tolerance dose of 5,000 r on the basis of the reaction obtained in this region, whereas the author himself has found that in other regions, as for example in the back, the dose may be increased to 5,500 r or 6,500 r.

All in all, the epidermiolytic dose exceeds the usual skin erythema dose at least ten to twelve times. How such a dose can be administered without danger of ulcer or necrosis is one of the unexplained riddles of roentgen science. According to the author, two factors may serve to furnish some sort of explanation: (1) that the expression of the skin tolerance in skin erythema dose must be erroneous, and (2) that the skin tolerance dose varies when the radiation is given at once or in fractions. But even so the author was able to administer a dose as large as 3,000 r in one sitting the reaction having disappeared with complete *restitutio ad integrum* and with no late ulcer showing up within six months, the longest period a patient was observed. If the dose was given in the fractionated way it could easily be increased to 6,000 r as indicated by Coutard. The author also investigated whether it is necessary to protract the irradiation when fractionating it as done by Coutard. This has a certain practical value inasmuch as the protraction consumes considerable time, necessitating the installation of many roentgen apparatus if one wishes to take care of a large number of cases. He found that an epidermiolysis of like degree can be obtained by the simple fractionating without protraction, that is, administering individual doses of higher intensity. The factors used were 0.5 mm. Zn, 30 to 40 cm. distance, 3 to 4 ma., 180 kv., 20 r per minute intensity (Coutard uses a smaller intensity).

In conclusion, the author compares the above doses as expressed in H in Vienna and in Paris and explains the difference (50 Paris H to 125 Vienna H) and the factors which lead to it.—*T. Leucutia.*

Jeanneney, G. Circulation locale et cancer. (Local circulation and cancer.) *Cahiers de radiol.*, Jan., 1932, No. 7, 154–161. Supplement to No. 2, Jan. 15, 1932, *Gaz. méd. de France.*

Skin cancer forms a good experimental subject because of its frequency and its accessibility. The author therefore has chosen this group for the study of the relationship between local circulation and cancer and he now wishes to generalize the results obtained, although certain reservations are necessary.

Skin cancer occurs most frequently on the face of aged subjects. The reason for this lies in the fact that the skin of the face develops a senile atrophy which is more marked than in other parts of the body. A study by Mme. Bellocq of the distribution of the blood vessels in senile skin, with the aid of opaque injections (térébenthine-minium) and subsequent roentgenograms, revealed that a veritable insufficiency of the local circulation develops with advanced age. A tabulation of some 300 cancers of the face observed at the Cancer Center of Bordeaux since 1925, with regard to the site, revealed that the frequency was greatest in the areas having the poorest circulation. It was further observed that cancers occur with predilection in scars of all sorts (following burn, ulcer, fistula, lupus, roentgen injury, etc.) and in areas suffering from vascular disturbances, such as syphilis (leucoplakia, endarteritis, phebosclerosis, etc.). This suggests that there is a close relationship between cancer and local blood supply of the area affected. The author is of the opinion that a prophylactic removal of all scars, a systematic treatment of syphilis, with complete suppression of tobacco and alcohol, might prove an efficacious means of combatting cancer. With the same view, he, in 1926, advanced the hypothesis that sympathectomy might have some value in the treatment of certain cancers by provoking vasodilatation and a better blood supply of the area affected.—*T. Leucutia.*

Fortes, Ary Borges. Syndrome de compression de la queue de cheval par un sarcome vertébro-méningé. (Syndrome of the compression of the cauda equina by a meningeal sarcoma.) *Rev. sud-am. de méd. et de chir.* Feb., 1932, *3*, 143–155.

The author describes in lengthy detail by using numerous illustrations, a case of sarcoma of the third lumbar vertebra which resulted in compression of the cauda equina. The case may be summarized as follows: A woman aged forty-three presented, during a period of $3\frac{1}{2}$ months, a flaccid paraplegia of the lower extremities associated with amyotrophia, grave sensory disorders (from L_4 to S_5), sphincteric troubles, pilomotor, vasomotor and thermic disorders, modification of the arterial pressure, and a typical cyto-albuminous dissociation of the spinal fluid. The roentgen examination showed destruction, with partial collapse, of the third lumbar vertebra, and some involvement of the adjacent second and fourth vertebrae.

Autopsy revealed that the above syndrome was the result of pressure of the tumor which proved to be a primary sarcoma originating from the dura mater on the cauda equina. A surgical intervention was impossible because of the very marked cachexia of the patient.—*T. Leucutia.*

Lacassagne, A. L'organe folié de la langue, cause possible d'un diagnostic erroné de cancer. (The foliaceous organ (organum foliatum) of the tongue as a possible cause of erroneous diagnosis of cancer.) *Radiophys. et radiothérapie*, Volume 2, No. 4, 587–594.

Mayer in 1842 described the foliaceous organ (organum foliatum) which is situated on each border of the tongue just in front of the insertion of the anterior pillar of the soft palate. If this organ is hypertrophied a confusion with cancer may occur. The author describes the causes of possible hypertrophy which may be (*a*) of congenital or (*b*) of acquired origin. In this latter group a lymphoid hypertrophy, similar to that observed in other tissues of the nasopharynx, is not infrequently encountered. The organ is important also because it may form the site of a chronic infection or of a beginning neoplasm, although this latter occurs less frequently than one would expect. Several plates are included showing the microscopic appearance and one drawing illustrating the clinical appearance.—*T. Leucutia.*